CA2 AL&G
50 H26
Nov 3/50
Vol 5

ALBERTA LEGISLATURE LIBRARY
3 3398 00206 9721

ALBERTA PROVINCIAL LIBRARY
EDMONTON

The Province of Alberta

PETROLEUM AND NATURAL GAS CONSERVATION BOARD

IN THE MATTER OF THE GAS RESOURCES PRESERVATION ACT

AND IN THE MATTER of a Joint Hearing to determine various questions relating to the proposed Export of Natural Gas from the Province of Alberta.

I. N. McKinnon Esq., Chairman

D. P. Goodall Esq.

Dr. G. W. Govier

Session: November 3, 1950.

Volume 5.

Digitized by the Internet Archive
in 2019 with funding from
Legislative Assembly of Alberta - Alberta Legislature Library

I N D E X

VOLUME 5.

November 3rd, 1950.

W I T N E S S E S

	Page
A. FAISON DIXON	
Direct Examination by Mr. Nolan,.....	382
J. R. DONALD (recalled)	
Cross-Examination by Mr. McDonald,.....	388
Cross-Examination by Mr. Nolan,.....	418
WILLIAM D.C. MACKENZIE	
Direct Examination by Mr. Hamlin,.....	422
Cross-Examination by Mr. Nolan,.....	436
Examination by Mr. C.E. Smith,.....	430
Cross-Examination by Mr. Nolan,.....	445
Cross-Examination by Mr. Steer,.....	447
Cross-Examination by Mr. Fenerty,.....	448
Examination by Dr. Govier,.....	449
Examination by Mr. Goodall,.....	452
RALPH E. DAVIS (recalled)	
Direct Examination by Mr. Steer,.....	454
ALBERT D. BROKAW (recalled)	
Direct Examination by Mr. Nolan,.....	458
Cross-Examination by Mr. McDonald,.....	459
Cross-Examination by Mr. Steer,.....	461
Examination by Dr. Govier,.....	469

E X H I B I T S

No.		
J-14	Report of Dr. Hume and Dr. Ignatieff on the Dinning Commission,.....	387
J-15	Submission by Imperial Oil Limited in regard to National Gas Reserves and other matters pertinent to Gas export,	421
J-16	Paper on Sample Grading of Estimating Gas Reserves, developed for the Permian Dolomite of the South Hugoton Field, presented by Mr. Davis,	457

VOLUME 5.

November 3rd, 1950.

MR. STEER: Mr. Chairman, Mr.Donald is here. Mr. McDonald wanted to ask him some questions, if he does so, could it be indicated when he might be required?

THE CHAIRMAN: Well, I thought we might just have Mr. Dixon finish presenting his exhibit and then call Mr.Donald.

MR. STEER: Yes, sir.

.....

A.FAISON DIXON, recalled, already sworn, examined by Mr. Nolan, testified as follows:-

Q Mr.Dixon, have you before you Exhibit J-13?

A Yes, sir.

Q Will you direct your attention, please, to page 20 of that exhibit?

A I start on page 20 a discussion of the repressuring of the Viking-Kinsella field, as Mr.Davis said in his testimony that no large reservoir is suitable for repressuring, he was speaking of Turner Valley, and certainly this is a much larger reservoir than Turner Valley and less suitable for repressuring, and if he is the expert for this group I do not consider it worth while to go through this as I judge that they have reconsidered the matter and have withdrawn their idea with regard to repressuring in the Viking-Kinsella field. If not, the record is here for anyone to see.

The second part of our discussion here is one in which we discuss the ownership of the Westcoast Transmission Company, the Alberta Inter-Field

and the Western.....

Q Not Westcoast?

A No, pardon me, of the Alberta Inter-Field, the two local Gas Companies in Calgary and Edmonton and the Western Pipe Line Company. I will not read this, but simply say that we have given the facts which show that the two local Gas Companies in Calgary and Edmonton are owned practically 100% and absolutely controlled by the International Utilities. The ownership of International Utilities is held almost entirely outside of Alberta and only a very small amount, as far as I can find out, is owned in Alberta.

THE CHAIRMAN: Excuse me just a minute, Mr. Dixon.

A Yes, sir.

Q All right, Mr. Dixon.

A The ownership is held almost entirely outside of Alberta, and that Mr. Milner owns 100 shares of the parent company, one of the directors, and Chairman of the Board of those Companies, Mr. Baxter owns 200 shares, wherefore Mr. Milner is simply the nominee and no more of the International Utilities, an American concern.

Q MR. STEER: You are talking about his holdings in which company now?

A In International Utilities. He owns, as far as I know, no stock whatever in the two local utilities, unless it is preferred stock.

The ownership of the Western and the Inter-Field is shown to be controlled by a group of bankers, all of whom have their head office

outside of Alberta.

MR. C. E. SMITH: We have the jury here, Mr. Chairman, but there is no accused in the box yet.

A I am saying this because there were statements made in the submission of the Inter-Field which were entirely contrary to fact, and I would like to bring the facts out clearly. On the other hand, the Alberta Grid Company is owned 40% by companies registered in Alberta and owned by Albertans, or owned directly by Albertans.

I would like to read my conclusion.

Q MR.NOLAN: That is page 28, Mr.Chairman, of the exhibit.

A Pursuant to the request of the Board, dated September 28th, 1950, Transcript 293, and addressed to all applicants and interested parties, we have endeavoured to comply fully with the requirements of the Board as set out in that request. We have left out of account all extensions of present fields, new discoveries and what seems to be the inevitable expansion in the development of oil and gas in the Province of Alberta.

Our estimate of the future requirements of Alberta is based primarily on the highest estimate made to date.

We have shown that it would be possible under ordinary oil and gas field practice to supply the Provincial requirements of Alberta for thirty years and the amount we request for export, 80 billion per year, for twenty years, taking into account only such fields as are now connected to dis-

tributing systems or will be connected by the gathering or grid system that we propose to build.

MR.NOLAN: Now, Mr.Chairman, there were two matters that I wanted to mention to Mr. Dixon.

Q First of all, have you had an opportunity of reading the submissions of the Western Pipe Line Company?

A Yes, sir.

Q Have you any comment to make on that?

A It seems to me that they essentially agree with me in my approach to the way that the gas will come out of an oil field, that the amount of gas will inevitably increase.

A There has been some discussion here, Mr.Dixon, about coring. Do you know something about coring?

A Well, it was a discussion on both coring.....

Q And cuttings?

A ....and cuttings.

Q Yes?

A I can say that I have had many many long years of experience working on cuttings. I go back to the time almost before we ever knew of a rotary drill and were trying to work on the cuttings from the sludge pit of a standard rig. We all know the difficulties. It is a hard thing to find out what you are going through.

Now, there is one po nt I would like to bring out, that in the case of cuttings or imperfect cores, if you are hunting for porous strata, the various strata, porous strata is what is impossible to show up in the cuttings unless it is very abundant and hard. The porous part of the formation are most fibrous and they become powdery, wherefore not finding porous

particles in the cuttings or in an imperfect core does not indicate that they are not there. If you do find them it indicates that they are there, or, at least, that they were there somewhere in the wells, but not finding them is purely negative and does not show that they were not there.

Now, the other methods of speed drilling and various types of electrologs and such things, they are also a great help. I do not say that we should not work on the cuttings all we should. And if Mr.Davis has found a way wherein he really uses cuttings and makes sense out of them, he is a better man than I am.

MR. C. E. SMITH: Gunga Din.

Q MR.NOLAN: I think there was a discussion between Dr. Beach and the Chairman on the question of the distinction to be drawn between proven and probable, and I thought that the Board would be interested in just a word from you, Mr.Dixon, on the differentiation between those two categories?

Q Now, in Mr.Hume's report, he states at the end of his introduction in discussing the proven and probable, that his probable by many engineers would be called proven.

Now, in my testimony recently before the Federal Power Commission on the Blanco Field and the Barker Dome in the Four Corners area of Utah, Colorado,Arizona and New Mexico, I gave testimony which I thought was very good, using as the basis the production of wells. One well had gone down to about 30% of its original pressure, and it produced over 1 billion cubic

feet, and in the other field, the Barker Dome, the pressure drop had been very slight. We had at that time very imperfect cores. I gave both the core data and the data on drop in pressure. Now, the drop in pressure data is what Mr. Hume calls proven and the other probable. The Federal Power throughout my data, which I thought was the best, on the drop in pressure, and took the imperfect core data as the better data. That shows that they were doing the very reverse of what Dr. Hume has done in his, and in the terminology I think in his mind he really has no distinction on whether the gas is there or not between proven and probable, it is just a matter of definition in the method of getting at reserves.

Q All right, thank you. Now, I think, Mr.Chairman, this might be a convenient point for Mr.Dixon to stand down, and the other witness to be interjected.

THE CHAIRMAN: Would you mind tabling this report now?

MR.NOLAN: Yes, sir. Throughout these proceedings, and since the report has been in existence, there has been constant reference made to the Hume Report, and many of the witnesses accepted the figures from the report and put them into the record. However, the report has not been marked as an exhibit and I think it should be given an official status, and I am going to tender it to the Board and ask that it be given a number and marked as an exhibit.

THE CHAIRMAN: Exhibit J-14.

REPORT OF DR. HUME AND MR. IGNATIEFF MARKED EXHIBIT J-14.

MR. STEER: As evidence of what, sir?

MR. NOLAN: As evidence of what is contained therein.

MR. S. B. SMITH: We can assume Mr. Nolan has 50 copies and will distribute them. You are not going to read it?

MR. NOLAN: I am going to spare my friends and not have it put into the transcript.

MR. MAHAFFY: In accordance with the usual rule, Mr. Chairman, I take it my learned friend will supply us all with copies.

MR. C. E. SMITH: If you will guarantee to read it from cover to cover maybe he will.

THE CHAIRMAN: Mr. Steer, would you like to call Mr. Donald now?

MR. STEER: Mr. Donald.

.....

J. R. DONALD, recalled,

already sworn, testified as follows:-

MR. STEER: I have no further questions to ask Mr. Donald, sir.

.....

CROSS-EXAMINATION BY MR. McDONALD:

Q Mr. Chairman, I asked that Mr. Donald appear today. Mr. Donald, I note in your remarks yesterday that you refer to the fact that Alberta was the only Province that is a gas-producing province. Now, you are aware that there are exploration and development operations proceeding in Saskatchewan and Manitoba and Northeastern British

Columbia.

A Yes, I have seen reports of that.

Q Yes. Now, if gas is discovered in Manitoba in commercial quantities, do you think that the development that you anticipate for Alberta will ensue to the same extent it would if gas was not discovered in Manitoba?

A Well, if conditions similar to Alberta developed in Manitoba, you would have two competitive economies.

Q You would have one area closer to the heavily populated parts of Canada, and industry moving from the East to the West would stop in Manitoba in some instances, would it not, if it was attracted by natural gas?

A I am afraid I did not get your point. You said industries?

Q That were attracted by natural gas from eastern Canada?

A Oh.

Q Some of them, at least, would find what they are seeking in Manitoba if the gas was there?

A I would expect so, yes.

Q Do you think that possibly should be taken into account by this Board?

A I do not know. I have no knowledge of, what should I say, of the oil business, or the probabilities, or anything of that sort, and I do not think I am in a position to make a statement on it, frankly.

(Go to page 390).

Q As I also understood your evidence yesterday, you advocate the retention of gas in Canada for the use of Canadians. That was the general tenor of your evidence, am I correct in that?

A Yes, I think so. I believe that Canadian needs should come first, certainly.

Q Now if the population in Canada is now not sufficient to warrant the development of industries based on gas that is now available, do you advocate that this generation of Canadians forego the use of some of that gas now available if this entails sharing the same with certain points in the United States?

A My attitude is that the Canadian requirements should be taken care of first, and after the immediate requirements are taken care of then I think consideration to the other factors should be given.

Q Now can you tell us whether you agree with the submission of Western Pipe Lines, for instance, that the delivery of gas to Minnesota, if necessary in order to get gas to Manitoba in commercial quantities, should be permitted?

A I do not think I should try to reply to that. In the first place, I do not know the details of that submission.

Q The reason I asked that question is that in the evidence submitted your firm was stated to be one of the engineering firms concerned with that venture?

A That is true.

Q And I take it that it has been concurred in by your firm?

A If you could show me the submission, I could tell you whether or not we have dealt with it.

Q No, your name does not appear. It appears under the name of Stone & Webster. But assuming that in order to get gas to Manitoba it is also necessary to go further and supply it to the State of Minnesota, according to the submission of the Western Pipe Lines that is correct?

A I do not doubt that, but frankly, I do not know the full detail of that submission.

Q And what have you to say about the British Columbia situation and making gas available to the lower mainland of British Columbia, the Vancouver area? In order to make natural gas available there it is also necessary that the markets of Seattle and Portland should be served?

A Yes, I suppose that would be so.

Q So that in the net result you modify your first statement that if it is necessary to do that, to serve some gas into the United States, that you would do so?

A What do you mean, "necessary"?

Q I mean that suppose Western Pipe Lines said that in order to take gas, say to the City of Winnipeg in commercial quantities, it is necessary that they also should serve the Minnesota market?

MR. MARTLAND: I do not believe there was any evidence to that effect.

MR. C. E. SMITH: Well, let us assume it.

MR. McDONALD: Yes?

A I assume if it is regarded as financially possible that such a line should be built.

Q If it is not economically possible, it will not be built?

A I do not know. As you know, there has not been a railroad

built in Canada that has not had Government subsidies.

MR. C. E. SMITH: There is a thought for you people.

Q MR. McDONALD: Is there anything else you wish to add to that?

A I cannot say any more than I have said. I believe the advantage of natural gas to a community is very great, but I think it is a problem that requires a good deal more attention than I have been able to give to it.

Q And that would apply to moving gas either east or west out of Alberta?

A Yes.

Q Now when we come to the question of the use of natural gas, do you agree with me that natural gas is primarily a fuel for domestic consumption?

A Yes.

Q And do you also agree that the use of natural gas to serve, say, 500,000 people in Saskatchewan and Manitoba and 750,000 people in British Columbia would be preferable to using the same gas as boiler fuel in Alberta?

A A great deal would depend on what you used the boiler fuel for when you get there. But I think generally speaking that I would agree that to use natural gas for domestic purposes is more desirable than as boiler fuel.

MR. C. E. SMITH: That is why you people put in this word "interruptible".

MR. McDONALD: We are coming to that later. Now let us say that you have a commodity which is in general use and can be manufactured in Alberta at a few cents

saving to the individual by the use of natural gas, should that be more preferable than using natural gas as fuel in the homes at a great saving over oil and coal?

A I think one of the matters to be taken into consideration in answering that question is in the use of the gas for manufacture and that is to consider the comparative cost. You would have to use the competitive costs of other fuels. There is no doubt about it that the householder could afford to pay a good deal more for these BTUs he is going to use than the boiler plant could.

Q The reason of this is it increases the standard of living?

A Yes. There is no question about it.

Q The general tenor of evidence before a Commission such as this, as discussed in the trade journals, is that natural gas should be conserved for domestic use?

A I think generally speaking the domestic use should have precedence over other things.

Q Now with regard to competitive fuels, would you agree that coal should be used for industrial heating uses where both coal and gas are available at almost equivalent costs for industrial use as primary fuel and when I am saying "primary fuel", that is boiler fuel?

A I do not see how I can answer that question directly. That question differs in each individual case.

Q Generally. Take the Canadian Utilities plant at Drumheller where coal is available at the door, should gas be introduced there if the cost per BTU to obtain the steam is the same?

A I do not think necessarily the question is entirely a

matter of cost. Would it not be a question of the availability of gas and the reserves of gas and the continuing position in those two things?

Q I am assuming of course that the Drumheller valley is not going to run out of coal. There is always going to be a plentiful supply of coal, and let us assume there is a plentiful supply of gas?

A All I am trying to say is, if I was going to study that matter, I do not think I could give a snap answer, I would have to go into it carefully, and you are asking me for a snap answer, which I do not think I can give.

MR. FENERTY: So far as you are talking, it will run out of gas?

A I may say that one of the problems that comes in there is that gas is such a very great convenience that in assessing the two things you would have to be very thorough about it.

Q MR. McDONALD: Would you agree with me that the use of coal would provide more labour, move more freight and a more varied distribution of wealth in Canada than the use of gas in equivalent BTUs in industry?

A I think in the long range you have a higher standard of living utilizing gas than coal.

Q But I am speaking only of industrial users, production, primary use?

A Will you ask me the question again, sir?

Q Would not the use of coal provide more labor and move more freight and a more varied distribution of wealth in Canada than the use of gas in equivalent BTUs in industry?

Using coal as a primary fuel in industry?

A That is a very difficult question. As I understand it, you are implying that as far as industry is concerned the over-all cost will be the same, is that it?

Q Yes?

A I do not know how to answer that question, frankly, because I am firmly convinced in my own mind that the availability of gas and its labor saving factors and its convenience and one thing and another are bound to be more attractive than the use of lower grade fuel. But when you put everything on the same cost basis, it is very difficult to measure. I do not know just how to do it, frankly.

Q I might just ask you this question. Would you recommend the deliberate supplanting of local coal in industry with gas if there is no appreciable saving as between the use of the two commodities?

A That is a theoretical question that is rather uncalled for because people do not spend money unless there is a reason for it. Nobody is going to make the substitution unless it is financially profitable.

Q Or unless there is some convenience factor?

A Well, that comes to the same thing.

Q I have in mind the competition of fuel oils, Mr. Donald. You realize, of course, Alberta has both oil and gas for industrial uses?

A Yes.

Q What do you suggest is to be done with the fuel oil that is a by-product of the Alberta refineries?

A I am not in a position to answer that question. It is too broad an economic question which would have to be carefully looked into and I cannot give you a quick answer.

Q Is it not possibly that fuel oil could be used as a primary fuel in Alberta of far greater benefit to the Alberta economy than in the case of natural gas for the same purpose?

A I am not in a position to answer that question. I think that is something that would require pretty careful study before an answer is given.

Q So that this whole question of the use of gas for industry in Alberta is related to its effect on both coal and oil. You have three primary products, three primary energy-producing agents here, coal, oil and natural gas?

A Yes.

Q And there is an inter-relationship between the use of the three as far as the economy of Alberta is concerned, is there not?

A Yes.

Q And that would require, as you say, a great deal of study?

A That is right.

Q Now, if I understood you rightly yesterday, you mentioned two major items that would control the time element in the introduction of industries by the use of natural gas in Alberta? First, growth in population and increasing markets in Canada?

A Yes.

Q Secondly, the matter of the reduction in United States tariffs?

A That is right.

Q Which would have the effect of increasing the population and the markets that would be served?

A That is right.

Q And thirdly, the results of the installations due to war emergencies, with the attendant disregard of ordinary economic considerations?

A Well I think I would draw a line at the last statement. I think in any planning that was done you would give every possible consideration to the economic factors.

Q Yes, but economic factors in the ordinary sense can be disregarded. In other words - -

A To some extent.

Q - - what I have in mind is this, the capital expenditure can be written off at a much greater acceleration than an ordinary business could afford to do so?

A Well, perhaps I could put it this way, that if you get into a real first class war emergency, capital expenditure becomes of relatively less importance.

Q Now there was one matter I wished you to tell me something about and that was the question of water. Would you agree with me that large quantities of fresh water free from undue hardness is a most essential requirement in many chemical industries?

(Go to page 398.)

A Well, most chemical industries require a first rate water supply. Any reasonably good water is suitable. In other words, a certain amount of hardness in the water is no particular detriment.

Q Now, isn't this factor of available fresh water a more important factor than your fuel element in the location and operation of an industry, of a chemical industry to which you have been referring?

A That is a problem you have to judge on the individual merits of the industry. There are chemical industries requiring very little water, there are chemical industries requiring a great deal of water, and there are chemical industries that require pure processed water. You have to judge it on the merits of the case. Generally speaking you would not set up a modern chemical plant without a good water supply.

Q Now, is it not true that the fresh water supply in the Bow River dictated the location of the ammonia plant at Calgary as one of the main elements in the location of that plant in Calgary?

A Well, I think perhaps that I should say this, that whether the ammonia plant had been located in Edmonton or Calgary, for example, a very satisfactory water supply was available at both places. I think there are other points in the Province where a similar condition exists. To say the only place in Alberta you could put the ammonia plant is Calgary, that is quite obviously incorrect.

Q I was not considering that, but that was one point that had to be considered.

A The ammonia plant requires a good water supply.

Q It must be cold?

A You certainly do not want boiling water but ordinary straight water is all right.

Q The temperature of the river has something to do with it?

A No, I do not think so. As a matter of fact, it would be very advantageous if it had been boiling water.

Q Now, can you tell me something about your investigations in these proposed industries that may come to Alberta with regard to the price of gas which such industries would contemplate buying, or they could pay and be economical. Now, let us take an example. For instance, we have two industries that you referred to, we have the Elk Point salt plant that you are familiar with?

A Yes, I am.

Q Now, what is the price of gas that is charged to that plant to make it a successful operation?

A Well, that plant has its own wells and I do not precisely know what the cost of the gas is to the plant but it is very low.

Q Now, the price of gas which is included in the statements which show that to be a successful operation, if it is, I do not know, do they include the exploration expense, the acquisition expense and the development expense of the leases which provide the gas?

A I can not answer that.

Q Now, dealing with that ammonia plant in Calgary, I think you stated yesterday the price of gas up to 1945 was about 9 cents per MCF and that was based on a 2 cent price at

the wellhead in Turner Valley?

A No, I made no statement of that sort. In referring to the value of it I took the gas at 10 cents or 14 cents, I do not remember, but I made no statement as to their contractual relationships for gas.

Q Up to 1945, I was saying. You will recollect, Mr. Donald, that you were in this room giving evidence in 1945 on that point, and I think the price was 7¾ cents at the gate of the company?

A I do not think I gave that evidence.

Q Well, it might have been the gas company at that time. Then you paid something in the neighbourhood of 1½ cents carrying charges. Am I approximately right?

A Yes, something of that order, if I remember it.

Q The price of that gas has gone up to what you mentioned yesterday, roughly 14 cents?

A Yes.

Q It depends on the amount used whether it is over 14 or maybe a trifle under?

A I do not know the contractual rate.

Q Now, in your opinion, in an industry operating as this ammonia plant is, can it stand an increase in price and still maintain its market?

A That is entirely a matter of a competitive position. Similar plants in the United States are operating on natural gas and the ability of this plant to compete will at some point get back to the competitive cost of operation, and that in turn will be dictated by the relative gas prices.

Q You can not tell us now whether any appreciable increase will affect the market available to this plant or not?

A The current market for nitrogen is so great that all plants, even those that would normally be considered uneconomical, are running. In a time of keen competition, which will probably come about, the higher cost ammonia plants will have to go out of business. Now, at what point that is reached, and what price of gas that will mean, I do not know, but I would say this, that from what I know of some of the operations in the Southwest they are paying less for gas than this plant is at present.

Q All I am trying to do is to arrive at some type of measure. Now, do you visualize in your concept of this chemical industry that may follow or may come to Alberta that those industries could obtain gas at lesser prices than are now prevailing, the same price or higher prices?

A I would say 14 cents was a relatively high price to pay for gas for many chemical operations.

Q Now, the industry that comes here has two choices, have they not, in regard to this supply of natural gas? One is to contract a supply from either primary producers or from a transmitting company, and the other is to acquire leases and explore and obtain its own supply. Are you agreed with me that those are the two alternatives?

A Well, I think perhaps - - I do not know what other alternatives there may be, but certainly they have got to get a gas supply however they get it.

Q Now then, the man who purchases the gas or the industry that purchases its gas from any producer or transmitter

must buy it at a rate which will include the acquisition cost of the lease, the expenditure in regard to exploration and the drilling or development expense and also the annual operating cost plus a profit?

A I do not think I can answer that question. I know that in a great many instances the gas that has been used in the Southwest States is essentially a by-product or gas that had to find a market for other reasons.

Q Yes, and that gas is not distress gas in the ordinary meaning of it, it means this, that must be disposed of under the law?

A Well, as I have said before, I am not too familiar with the petroleum industry, but I understand there is a good deal of gas comes to chemical industries in the United States which comes from fields which produce oil with a large percentage of gas and for which a market has to be found.

Q Turner Valley is a typical example of that type of field?

A I would think probably it was, yes.

Q And Leduc may become that type of field?

A I do not know.

Q But to actually go out and buy dry gas on the basis of exploration for gas and development of gas reserves, I interpret your answer to my question that the type of industry you have in mind can not afford to purchase and pay for such gas?

A You mean, they can not develop their own gas supplies?

Q If they do, they take into account all of those costs I have mentioned to you?

A As a matter of fact, there are a number of these larger chemical companies in Texas who have done that very thing, they have their own gas supplies.

Q In that case they then pay what any producer would charge them for the gas?

A Does not that get back again to the question of what is produced at the well, whether it is gas only or gas and oil?

Q Yes, but I am trying to ascertain from you your conception of this industry based only on the very cheap gas which you expect to be available from an oil and gas field, or are you looking for gas from a natural gas field developed for the production of gas only, such as Viking, for instance? I mean, where are you going to find your gas for industry, and what can they afford to pay for it?

A Well, I would think that this industry developed here, as it eventually will, I do not know how long it will be, you will have both types of operation and it will depend on the type of operation if they can afford to pay for the gas and the characteristics of the gas. It was brought out here, I think, very clearly yesterday that not many of these operations are dependent on the ethane-butane-propane fractions.

Q Which is obtained particularly from the oil-gas field absorption plants?

A It is obtained from the oil fields. It is obtained usually in conjunction with a certain amount of oil, certainly.

Q Now, I would like to try to ascertain what your conception is of the amount of gas that possible industries

may use. Now, in answer to a question, I think of Dr. Govier yesterday, you pointed out what you have just mentioned, that what these industries really are looking for are the L.P.G.'s which are the product of the absorption plants or of the oil refineries?

A Well, they want a combination of raw material and heat.

Q Yes, plus the gas for fuel?

A That is right.

Q For boiler purposes, yes. And that the ideal place to obtain those would be from the location either at a refinery point or at a field plant station?

A Well, it again becomes somewhat a question of the type of operation. For example, as I tried to point out yesterday, ammonia, methanol and some other things use dry gas.

Q Now, have you any idea as to the amount of gas that is used in the chemical industries in the United States?

A Following your question, Dr. Govier, I thought I had the data with me and I was not even able to get the exact data I want, but in 1947, according to the Federal Power Commission, there were 415 million U.S. gallons of butane, of L.P.G.'s used by the chemical industry for process purposes. There is no similar figure available for dry gas but it is intimated that the dry gas figure is very large. The exact wording is that over seven times the amount of volume of gas was used for fuel as was used for processing, but unfortunately there are no figures that are available later than 1945, which is an unsatisfactory figure because in 1945 there was the readjustment in industry with a great many of the chemical plants at that

time shut down. I would like to try and get that figure for 1947 and I shall do so. I would think that the natural gas figure for both processes, that is the dry gas figure for both processing and chemical purposes is going to get into, I would think it would be figures of 200 and 300 billion, something of that sort.

Q Now, if you take 10% of the 415 million of U.S. G., that gives you 41,500,000 U.S. as a 10% figure?

Q DR. GOVIER: It would be somewhere around 3,000 barrels a day, would it?

A Well, I would have to divide that out, which I have not done.

Q Do you suggest that, Mr. Donald, as a possible maximum figure or a possible reasonable figure?

A Well, the use of these things in the United States is going up by leaps and bounds and I would think that while you might look at the 10% figure as something within, say, 10 years, I think you would have to look for increases following that at the rate at which these industries are developing. One factor one always has got to remember is that the establishment of these large chemical plants takes time. The engineering alone is a very big job, as well as construction. If someone were going to put a plant in tomorrow it would take two years to get it in at the best.

Q MR. McDONALD: Is that all you have in reply to Dr. Govier's question?

A Yes. I am sorry I have not been able to get any further figures.

Q Well, you will recollect that in the Dinning Commission

presentation was made by H. Zinder, utility consultant, who was employed by the Commission. Did you know that part of his duties was to make a study of the industry in Texas for the purpose of ascertaining the amount of gas required in Texas and consumed in Texas up to the year 1947? Now, in his report to that Commission he set up the natural gas disposition in Texas from 1944 to 1947 and he showed in 1945 chemicals - - now, that does not include rubber products, and it does not include ceramics and it does not include glass products or paper and pulp, it is just chemicals which I would say would be the petrochemical classification.

A Does it include carbon black?

Q No, not carbon black, no. Now, he has the figure as you mentioned, 7 billion in 1945, for 1946 he has 10 billion, 1947 12 billion. For ceramics he has 3 billion in 1945, 4 billion in 1946, 4 billion in 1947. Glass products are 1 billion throughout the period. With regard to rubber products he has 33 billion in 1945, 37 billion in 1946, and 25 billion in 1947. Have you any additional information that you want to give in regard to it?

A Well, the usage of those things has been going up steadily since then. If his figures were right you would have to add very considerably to those totals. Whether they are or not, I do not know. You would have to study it pretty carefully.

Q The only other point I had connected with those figures is this, up to 1945 you mentioned there was a billion dollars spent in the Texas area on those plants?

J. R. Donald,
Cr. Ex. by Mr. McDonald.

A Yes.

Q Now, of that billion dollars I would say the rubber plants had a very substantial portion, had they not?

A Yes.

(Go to page 408)

Q Now,apart from the rubber, do you show that other plants in 1945 after the expenditure of vast sums only required 7 billion cubic feet?

A Well, I think that is using the figure there. It is not including in that figure, I think, the heat use and is only taking the processed gas.

Q No, no, didn't you just a moment ago tell me that the heat used in the chemical industry was 7 to 1? The amount of that gas in 1945 that was actually used in industry, taking a chemical breakdown, was 1 billion and 6 billion was the heat used wasn't that what you said a moment ago?

A I said the difficulty was to get any figures, did I not?

Q No, didn't you use that figure a minute ago, because it coincides with what is here?

A I do not remember using it, but perhaps we could find out. The difficulty is I cannot get that figure at the moment.

Q That figure appears in this report for 1945, or a figure very similar to that?

A The trouble with the 1945 figure is that it was the year in which the war ended and a great many of these plants were shut down or being readjusted.

Q Yes?

A And I do not think you can take a figure at that time; you have got to take a figure about 1947.

Q This report was brought up to date by the direction of the Dinning Commission up to 1947?

A I think he probably used the figures that are here.

Q Well, what comment have you to make on that? Wouldn't

you say, I am speaking of natural gas itself, that 1 billion out of the 7 billion would be the proportion as between fuel use and the chemical use?

A That is the figure that was used in this study that was made by the Federal Power Commission.

Q Yes, I think that is the source.

A In the case of the ammonia plant here, about two-thirds of their gas is used for heat rather than as a processing material.

Q Now, let us deal with the rubber plants?

A Yes.

Q Can you tell me of any synthetic rubber plant that has ever been built other than on a subsidy from some government?

A Well, I think perhaps - the only answer I can give you is that during the war time a rapid and necessary expansion took place in which the rubber industry was promoted by the government in some way, shape or form.

Q Yes?

A There is no doubt there were, prior to the war there were a number of small productions of synthetic rubber of varying types, but nothing on the scale that came after the loss by the United States of the availability of the natural rubber.

Q They were of a pilot plant type?

A No, it was much more than that, but they were not attempting to replace natural rubber in the main.

Q Now, the plant at Sarnia is definitely a Crown corporation?

A Yes.

Q Now, I was interested in your suggestion that if a rubber

plant was to be built it possibly could be built in Alberta, relying on the natural gas?

A The essential raw materials are here, yes.

Q Now, isn't it just as possible to locate a rubber plant at Montreal where there is also a concentration of refineries which would produce the same raw materials?

A You would have to measure the quantities of the raw material available together with the relative costs and the competitive use. One of the difficulties in synthetic rubber production is that the raw materials are directly competitive, for example, with high octane anti-knock gases.

Q Yes?

A And it is also competitive with some other things, and the location of another synthetic rubber plant in Canada would require very careful study.

Q Yes?

A At the time the plant was put in at Sarnia, and I had some knowledge of the matter, that was the only point in Canada where we could get a sufficient quantity of the raw materials that were required.

Q Well, now, there has been no increase in regard to the rubber plant since the war?

A Oh, yes, the capacity of the Sarnia plant has been very substantially increased since the war.

Q Well, wasn't it then - weren't all these assets that you mention in Alberta available when consideration was being given to the increased size of the plant, and why wasn't it divided up and built out here?

A There is a very simple answer to that. It is always cheaper to expand a plant than to build a new one.

Q Yes?

A And the availability of knowhow is a matter of very great importance on any relatively small expansion.

Q Regarding these butanes, Mr. Donald, you have been aware, of course, that butanes have been a drug on the market for a good many years at the Imperial Oil Refinery? You have been aware of that, have you not?

A No, I have not, as a matter of fact.

Q Do you know how the butane at that refinery is priced? Are you aware of that?

A No.

Q Well, the butanes that are a by-product of the isobutane plant that are not required actually in the consumption, in going into aviation gasoline and the ordinary gasoline, do you know what disposition is made of it?

A No.

Q It is used as fuel, would you agree with me on that?

A I think it is probably.

Q Do you know how it is priced?

A No.

Q It is priced on the equivalent BTU value of gas at Turner Valley. Now, wouldn't that be very very cheap butane?

A Yes, it should be. It is the sort of thing that you require in chemical operations. You have got to get back or you should get back pretty well the fuel values.

Q And that has been available in Calgary since the isobutane plants were put in in 1941 in considerable quantities?

A I do not know the quantities, but I am sure of this, that the quantities there are much too small for any of these major developments such as sunthetic rubber. I am quite

sure of that.

Q Well, I see. Well, in order to get butane then in the quantity for a rubber plant, you are going to have an operation that is many times the size of the operation in Turner Valley? In other words, it is going to be better than 20 billion cubic feet a year of dry gas, you have got to have that available before your butanes are going to be available?

A Oh, I do not think I can go along with that. In the first place, to get the butane propane gas from the crude oil separation, you get it from there, and the quantities will always vary with the percentages in the product coming out of the ground.

Q What I am trying to find out is, whether this rubber plant is a matter that is attached to an oil refinery and dependent on the oil refinery, or whether it is dependent on the natural gas industry?

A Now, if you take it as suggested by the Alberta Research Council, you would have to have a lot of butane, as suggested,wherever you get it.

Q It could be got from gas refineries?

A Not essentially from refineries. I think it would have to come from a field separation plant.

Q And in order to get the field separation plant you would have to have some disposal of the dry gas, would you not?

A I presume so, yes.

Q And that leads me to the rubber plant in Texas. Are they not the by-products of pipe line gas, or put it the other way, aren't the merchantable pipe line gases in Texas the

by-products of these plants which produce the butane?

A I cannot answer that question as I have no direct knowledge of it, but I would expect that if those plants are using the L.P.G.'s, that they will reach some point where they are available very cheaply.

Q I think you have agreed with me that you have got to have a large disposal of dry gas in order to arrive at the quantities of butane required for a rubber plant?

A No, I do not know that is true. I do not know, for example,- I do not know that the amounts of dry gas available, for example, from the Leduc field,in relation to the L.P.G.'s, I don't know what that ratio is, or how high it is.

Q Well, again you are tying your answer to the oil/gas fields and you are excluding,by inference at least, excluding dry gas fields?

A Well, the dry gas field has no butanes and propanes.

Q So that as far as the answer generally is concerned, outside of the one type of ammonia plant or methane plant, it has no bearing on this industrial development that you are speaking of?

A No, I wouldn't limit it to the two types of plant only. You have got to take into consideration other things, various other things. The suggestion was made that carbon black might be made here, which would be a dry gas proposition.

Q I think in this Province we have put carbon black in a class by itself?

A Well, I think that is an error. Carbon black is absolutely essential to rubber manufacture. It composes about one-third of the weight of the finished rubber tire. It

adds very greatly to the strength and it is just as valuable as the rubber in the tire, and at some point that fact is going to be recognized.

Q Yes?

A In other words, when you are producing carbon black you are, to all intents and purposes, producing rubber.

Q Now, there is just one more point, sir. You have mentioned smelters?

A Yes.

Q Now, do you know of any smelter or refining plant in regard to metals that is located near a natural gas field?

A Well, I do not offhand, but I do know that natural gas in a general way is used, when it is available, in smelting operations,but I cannot give you any precise information.

Q Can you tell me any place where the ore has been taken or the concentrate has been taken to the natural gas fields' smelter?

A Where the ore has been taken to?

Q Yes, to the natural gas field?

A To the source of natural gas?

Q Yes?

A I have really no information on that.

Q Yes. I am suggesting to you that the gas has always been transported to the smelter where it is used. It has got to be transported in some shape or form?

A You mean how far?

Q I mean a long distance?

A No, I do not think so necessarily. I do not know, frankly.

Q All right. Now, could you just attempt to give some consideration to the immediate future - what I mean when

I say that, the immediate future, I mean the next three years - could you give us, without giving us the names, if they are confidential, some idea of the amount of investment, the amount of gas, and the classification of gas that may be required by the industries who have consulted with your firm, or that you have knowledge of, that are coming to Alberta, or that would like to come to Alberta?

A Well, these conversations we have had are entirely exploratory, and the only thing I can say about it is that the capital requirements for that type of industry that they are willing to enter into would be very large. How large I cannot say offhand, but it will be in the millions. I would like to refer back again to the smelter question, and the point I want to make is that in the smelting of metals the smelter is usually located near the source of the fuel supply and not the ore supply. That is particularly true, for example, of your steel industry.

Q Yes? But you still do not recollect any smelter in a natural gas field, at the source of natural gas?

A I cannot give you any. There is none in Canada, certainly; and I do not know enough about the American smeliting industry to be able to answer that.

Q Now, with regard to your answer to my previous question, the conversations you have had are purely exploratory?

A That is right.

Q Now, there is just one thing I wanted to discuss with you, and that is this ammonia plant here, having regard to the possible investment. As I understand it, the ammonia plant was built originally by Governmental

authority?

A That is right.

Q And I understand the investment is common knowledge. Can you tell me what it was?

A Well, I cannot give you any exact figure, but it was on the order of $10,000,000.00.

Q I was wondering if it isn't right that the particular smelter plant here was always advertised in years back as being around $20,000,000.00?

A No, I never heard that figure. However, it is not correct.

Q Was it closer to $14,000,000.00?

A No, I think it was $10,000,000.00.

Q I have in mind that it was $14,000,000.00?

A Well,without referring to actual facts and figures, I am not sure, but I think it was on the order of $10,000,000.00.

Q Now, what was the investment in smelter plant at Trail, making ammonia under different processes, which was also built by Governmental authority?

A The plant was a joint operation by the Government and the Company.

Q Yes?

A And the money was put up by the Government and the Company. I do not know what that investment was, but the investment in making ammonia from coke per ton of ammonia is somewhat less than ammonia from natural gas, but they are not tremendously different figures.

Q Now, what did the Alberta Nitrogen Plant, or the Company, the Consolidated Mining & Smelting Company pay for the installation at Calgary?

A I do not know.

Q You do not recollect the figure of $5,000,000.00 with regard to that?

A I have heard various figures bandied about from $7,000,000.00 down, but I haven't heard the exact figure.

Q Wasn't the figure published in the Government papers, published by the Government in papers as $7,500,000.00 for the two plants, the plants at Trail and Calgary?

A Yes, they were published.

Q They were published?

A Yes, but I do not know.

Q But, I am suggesting to you, with regard to that, first, that the investment has been written down, and, secondly, that the price of gas is very low?

A In the first place, it is in competition with American plants which would dispose or provide industry pretty much in the same way, so that they are in direct competition on the capital score. On the gas score I think you will find, as I said before, that some of these ammonia plants in the United States southwest are paying less for gas than the Calgary plant. They certainly were during the war.

Q Now, you follow industry in Western Canada, as I understand it, particularly with regard to this gas situation. Can you tell me anything about the lay-off in the Medicine Hat Pottery plants following the devaluation of the pound?

A I never even heard of it.

Q You never even heard of it?

A No.

Q If you do not know you cannot tell me. Thanks, Mr. Donald.

.....

CROSS-EXAMINATION BY MR. NOLAN:

Q There was one thing I was going to ask Mr. Donald, if I may. I will be very brief, sir. Mr. Donald, as I understand your evidence, you are loathe to favour the export of gas because you feel that there is strong possibility of the establishment here of chemical industry?

A Well, what do you mean by export?

Q I mean, getting it out of Alberta and out of Canada?

A I have never felt, as a Canadian, that there was any objection to Alberta gas going to the rest of Canada. I do not feel that there is any objection to Alberta gas going to the United States providing that our industries are protected in some way.

Q Yes?

A In other words, they should not have everything stacked against them in the way of tariff.

Q And there should be sufficient reserves left here for the creation and establishment of new industry, chemical industry?

A Yes, that is right.

Q That is the substance of your evidence?

A Yes.

Q And, to put it to you more concretely, this is what you said at page 297 of the record yesterday, "Currently, there is a good deal of activity in the investigation, activity and investigation of the possibility of the establishment of new chemical industries in Alberta. And, more recently, several groups have been studying them, and I happen to be familiar with the work they are doing." That is what you told us yesterday?

A That is right.

Q Now, when you were before the Dinning Commission, Mr. Donald, in January of 1949, you were discussing this same problem, and perhaps you will let me read to you what you said then?

A Yes.

Q "I would like to say to you that this question of United States chemical industry considering establishments in Alberta is not just a matter of fancy. It is a matter of fact. A number of the larger chemical companies have been studying this Alberta situation. My own organization has a request from one of the larger users of petrochemical to advise them in general on this situation, and they talk in very substantial quantities of natural gas and propane and butane."

A Yes.

Q You remember telling the Dinning Commission that?

A Yes.

Q How many new chemical industries have come into Alberta between January 27th, 1949, and the 2nd of November, 1950?

A As far as I know, none.

Q So that there has been no change in the situation in a period approximating two years?

A Yes, there has been a very definite change.

Q Yes?

A The inquiry we dealt with at the time of the Dinning Report, after investigation, it was demonstrated that the quantities of L.P.G.s in particular were not available to meet the type of requirements that existed.

The same inquiry is again being reviewed in the light of further developments.

Q But the fact remains that no new industries have come in in the meantime?

A That is right.

Q Thank you.

THE CHAIRMAN: Thanks, Mr.Donald. I think we might recess now.

(Hearing resumed after short adjournment).

MR.NOLAN: Mr. Chairman, before the proceeding resumes, I am going to ask the Board if it would be possible to let Dr. Brokaw complete his cross-examination. I am informed by Dr. Brokaw that it is important that he leave Calgary. He has been here for a very long time. It may very well be that the cross-examination of Dr. Brokaw will not be prolonged. I was wondering if counsel could give the Board any indication as to whether or not they intended to cross-examine him, because if it only means going back in the box for a few minutes, it would be of the greatest convenience to him if that could be arranged.

MR. C. E. SMITH: Mr.Donald was only coming back for a few minutes too.

MR.S. B. SMITH: For the purpose of facilitating the hearing, I am pleased to say that I do not intend to cross-examine Dr. Brokaw.

MR.C. E. SMITH: I would say that I would not know how, so that fixes that.

MR.NOLAN: Well, I think, sir, that it

could be disposed of in a minute or two, if you will permit me to put him back.

THE CHAIRMAN: Mr. Nolan, we had arranged to have Mr. Mackenzie here this morning. Mr. Mackenzie definitely has to leave, and we want to get his evidence in, and then Mr.Davis apparently wants to make a further submission.

MR.NOLAN: I know, but if there is no cross-examination of Dr. Brokaw there is no time lost.

THE CHAIRMAN: I understand Dr.Govier wants to ask him a few questions.

DR. GOVIER: I am sorry, Mr. Nolan.

MR NOLAN: Of course, I must not deprive Dr. Govier of that privilege.

THE CHAIRMAN: We certainly will have Dr. Brokaw on the stand this morning for cross-examination if there is time, but I think we did agree to have Mr. Mackenzie go on today, and I would like to have his evidence.

MR.NOLAN: All right, sir.

MR.HAMLIN: Mr. Chairman, I am representing Imperial Oil Limited, and I would like to call Mr. W. D. C. Mackenzie, Assistant Division Manager, Producing Department, Western Division, to make a statement on behalf of the Company. I have given you copies of the submission and filed one with the reporters. I will call Mr. Mackenzie.

THE CHAIRMAN: That will be marked Exhibit J-15.

SUBMISSION BY IMPERIAL OIL LIMITED IN REGARD TO NATURAL GAS RESERVES AND OTHER MATTERS PERTINENT TO GAS EXPORT MARKED EXHIBIT J-15.

WILLIAM DONALD COSSAR MACKENZIE,

having been first duly sworn, examined by Mr. Hamlin, ~~tesi-~~ testified as follows:-

Q Will you just proceed with the reading of your statement, Mr. Mackenzie?

A Yes. It is our understanding that the Board would like to hear evidence from producers in regard to reserves, deliverability, and future development of natural gas reserves; accordingly, I shall attempt to subdivide my remarks into these three general headings. In the interests of brevity and simplicity I shall cover certain aspects of these matters in summary form.

I. RESERVES

Approximately two years ago Imperial conducted a geologic and engineering study on gas reserves in areas where they then had interests, for the purpose of giving evidence at the Dinning Commission. Since that time we have not devoted much effort to the study of natural gas reserves. We have followed the work done by Messrs. Hume and Ignatieff who, as you know, have emended, revised and added to the report they prepared two years ago on natural gas reserves.

Approximately one year ago we sold our entire interest in the Viking-Kinsella gas field to the Northwestern Utilities Limited, and about six months ago we disposed of all our interests in Turner Valley.

Thus, as matters stand today, we have an interest in gas reserves in the following

partly delineated areas: Leduc-Woodbend, Redwater, Golden Spike, Excelsior and Provost, in addition to which we have interests in a number of areas which have not even been partially delineated.

Our reserve estimates are summarized as follows:-

PARTIALLY DELINEATED

(a) Solution Gas and Gas-Cap Gas Associated with Crude Reservoirs

Leduc-Woodbend D-2 - Our engineers have calculated the solution gas recoverable from this reservoir at 95,400 MMCF. They have assumed a reservoir abandonment pressure of 250 p.s.i.a.

Leduc-Woodbend D-3 - Our engineers have calculated the solution gas recoverable from this reservoir at 859,000 MMCF, assuming a reservoir abandonment pressure of 100 p.s.i.g. About two-thirds of the total is reservoired in the gas cap - the balance is in solution in the crude.

Redwater D-3 - Our engineers have estimated the solution gas recoverable in association with the produced oil from this reservoir at 82,300 MMCF. They have assumed a minimum reservoir pressure of 485 p.s.i.g., which is the bubble point pressure of the reservoir oil, and above which pressure it is hoped to produce practically all of the recoverable oil.

Golden Spike D-3 - O r engineers have estimated the solution gas recoverable in association with the produced oil from this reservoir at 24,000 MMCF, assuming that practically all of the recoverable oil will be obtained from the reservoir at pressures that are held above bubble point pressure (1370)

Excelsior D-2 - Our engineers have estimated the recoverable reserves at 2,100 MMCF, again limiting the

estimate to solution gas produced from the reservoir in undersaturated condition (above 915 p.s.i.g.)

(b) Dry Gas Reserves - (Pool Partially Delineated)

Imperial has an interest in only one reserve in this category and that is the Provost pool. Production is from the Viking sand. Our engineers have calculated the reserve at 97,000 MMCF, with an abandonment pressure of 200 p.s.i.g.

RESERVES INDICATED BUT NO DELINEATION DRILLING

(a) Solution Gas and Gas-Cap Gas Associated with Crude - (Pools not Delineated)

Imperial has interests in the Stony Plain-Acheson area where crude has been discovered in the Devonian and it is indicated that the solution gas might be an important reserve. In view of the fact that delineation drilling by ourselves or other members of the industry has only just commenced, we hesitate to make any estimate on what the reserve might be. At Normandville, in the Peace River region, we have one producing crude oil well, but we have done no development drilling in this particular pool so we do not know what the reserve would amount to. It is our general opinion that in the Normandville field itself the reserves will be of little consequence.

I might say at that point that Imperial's efforts have been directed towards wildcat and stepout drilling to evaluate the broader possibilities of the region rather than by development drilling in the pool itself.

(b) Dry Gas Reserves - (No Delineation Drilling)

As has been pointed out to this Board in previous testimony, there are a number of locations in the province where a well has encountered dry gas in the course of drilling for oil. Imperial has had this experience along with other members of the industry in both their own wells and in wells drilled in partnership with others. It is extremely difficult to make a reliable estimate on the magnitude of the reserve when only one well has penetrated the accumulation. Under certain circumstances it is considered reasonable to use the seismic interpretation for the pool outline. In other areas sucha procedure may not be reasonable inasmuch as the accumulation may be related to porosity and sedimentation variations rather than to structure as interpreted by the seismograph. Dr. Hume and Dr. Ignatieff adopted the arbitrary principle of taking a one-mile radius around a single well (in certain cases where there were two or three wells they modified the procedure slightly). In certain instances where we considered the seismic outline might be a reasonable basis on which to estimate the pool limits, we compared our estimate with the Hume-Ignatieff estimates and concluded that their approach was conservative. Consequently, it is our opinion that the estimates classified by Hume and Ignatieff as probable can be considered as reliable minimum estimates - at least in areas where we have interests.

II. DELIVERABILITY

We have made no specific study of deliverability of gas production either in areas where we have interests or in other areas. Consequently, any comments on this subject will have to be of a general nature.

The deliverability of solution gas and gas-cap gas in the Leduc-Woodbend area is directly related to the production of oil and is, in our opinion, subservient to the production of oil. The present-day picture on deliverability of solution gas from the Leduc-Woodbend D-2 and D-3 is simply a discussion of Imperial's gas conservation plant in this area. At the present time this plant is capable of delivering 16,300 MCF per day of residue gas to domestic markets, all of which has been committed. Generally the process equipment in the plant has been designed to handle 24,000 MCF per day, and by the addition of one compression unit and some other equipment the plant can be operated at full design capacity, so that deliveries of residue gas could be increased to 21,600 MCF/D provided, of course, crude production can supply the gas. The gas in the D-3 gas cap should not be produced until the oil in this reservoir has been pretty well depleted. This reserve of 600 MMMCF will therefore not be available for market for some time to come. Naturally it will be of interest to the Board in considering the long-term future of gas reserves in this Province to estimate when this reserve might be available

for consumption. A very rough figure of 25 years is submitted; however, this is a judgment figure and is not based on any long-range study of crude oil outlets.

Naturally a certain amount of solution gas will be consumed as field fuel during the producing life of the Leduc-Woodbend field. I believe the Board will appreciate the fact that 100 per cent conservation is not always practical - there will be some gas produced which cannot be economically gathered and processed; also at certain times production of gas may exceed the design of the field system. Due allowance will have to be made for allthese factors. Thus, if we consider the producible solution reserve as 310 MMMCF, and arbitrarily assume that about 40 per cent is consumed in lease fuel, plant fuel, and flaring of uneconomic gas, we might look forward to delivering about 180 MMMCF to market during the next 25 years. The deliverability of the gas-cap reserve of 600 MMMCF after the depletion of the oil is an unknown. From what we know today there should not be any special physical problems in deliverability. We would not want to guess what economic problems might be involved 25 or 30 years hence.

This discussion on gas deliverability from the Leduc-Woodbend field has been brief and the figures presented represent general conclusions. Quite possibly there is a real danger in over-generalizing; consequently, at this point I would like to make certain qualifications.

W. D. C. Mackenzie,
Dir. Exam.

1. In engineering calculations it is not possible to merely subdivide the D-3 reservoir into solution gas and gas -cap gas.
2. While the circumstances today are that only an infinitesimal amount of gas-cap gas is being produced from the D-3 reservoir, such will not always be the case. Later in the life of the pool some gas-cap gas will "break around" and be produced with the oil. This will be held to a minimum by the operator in accordance with good pradtice, using packers, squeeze cement jobs, etc., - however, the fact remains that a certain amount of gas from the D-3 gas cap will enter the bore holes through perforations which are now opposite oil saturation.
3. When the recoverable D-3 oil reserve is pretty well depleted an appreciable amount of recoverable solution gas will remain in the reservoir. This remaining recoverable solution gas will not come out of solution until the pressure of the gas cap has been pretty well depleted.
4. The rate of production of gas from the Leduc-Woodbend field is directly related to two factors--first, the reservoir characteristics of the pools, and second, the rate of crude production. I should like to put considerable emphasis on this second factor. The best reservoir engineering calculations will have very little value in determining the rate of production if there is a marked change in the crude oil outlet picture in the future.

Our most recent studies on the Golden Spike reservoir indicate that it would be advisable to go to gas injection in this reservoir to get the maximum efficient recovery of crude and, accordingly, the solution gas reserve will not be available for immediate markets. The gas so injected will be available only after the oil in the reservoir has been pretty well depleted --a situation similar to the Leduc-Woodbend D-3 gas cap mentioned previously.

At Redwater and Excelsior the amount of gas in solution is relatively small and at this time it is difficult to say how it could be economically gathered and utilized.

III. FUTURE DEVELOPMENT OF NATURAL GAS

From a crude producer's standpoint it is desirable to again discuss this subject in relation to two types of gas reserves--the first, solution or gas caps associated with crude oil reservoirs, and second, dry gas reservoirs.

In our view, one of the principal functions of the Alberta Petroleum and Natural Gas Conservation Board is to see that natural gas, produced in association with crude oil, is conserved. For all practical purposes natural gas produced in association with crude oil can be conserved in three ways:

1. Injection into underground reservoirs for storage purposes only.
2. Injection into underground reservoirs to augment reservoir driving mechanisms.

3. Sale of the gas to fuel and other energy markets.

Items 1. and 3. are inter-related to a certain extent inasmuch as storing gas underground usually contemplates the sale of that gas at some future date.

Let us now look at the oil discoveries in the Devonian in central Alberta in a very general way. Leduc and Redwater are major oil pools. There is reasonable expectation that Stettler, Flint, Big Valley, and Stony Plain-Acheson, may also be major oil fields. In all cases the oil is pooled in Devonian reefs. In the D-3 reef at Leduc and Redwater there is now a fair indication that bottom water influx will be an important and efficient driving mechanism, in which case gas injection may not be necessary for the efficient recovery of oil. I suggest that in future there will be other major accumulations in the same category whether these future cases happen to be Flint, Big Valley, Stettler, Stony Plain-Acheson, or not, remains to be seen, but we feel confident that this situation will arise. Therefore if the gas produced in association with the crude need not be injected into the reservoir, how shall it be conserved? It seems to me that the simple solution is to sell the gas as a fuel or energy source. Naturally in order to sell it an economic market is required, and to deliver it to this market the gas must be gathered and processed. Thus looking to the future it can be concluded that one of the most practical methods of practicing conservation would be the develop-

ment of new markets for Alberta natural gas.

The future of dry gas reservoirs insofar as Imperial is concerned amounts to a discussion of probable reserves which have not been delineated. As mentioned previously, in the course of our search for oil we have encountered dry gas accumulations but have made no attempt to delineate them. Specific instances are tabulated below:

Bath Creek (Picardville)	
Calahoo	
Cardiff Giant	
Jarvie	
Legal	
Manawan (Bailey Long Island)	
Morinville 1 & 2	
Plain Lake	
Waybrook	
Grouard	
Stony Plain	(dry gas in Viking)
Acheson	(dry gas in Viking)
North Woodbend	(dry gas in Viking)
Figure Lake	
Clyde	
Gibbons	
Lily	

There are three instances where crude production is also encountered but what is referred to here is dry gas above the Devonian.

We have taken the position that we do not wish to make capital expenditures to delineate these occurrences of dry gas until such time as we have a better assurance that the gas can find an economic outlet. There is another problem which adds a further deterring factor and that is the question of Crown reserves. It is difficult to clearly and briefly explain how the establishment of Crown reserves affects dry gas development. The

following factors are all related to this question:

1. Present Alberta Government statutes and regulations require square mile spacing for dry gas development.

2. Under certain conditions engineers would agree that square mile spacing is satisfactory and even wider spacing may be desirable. (Of course there can be exceptions.)

3. The wide spacing is difficult to organize when there is a diversity of mineral ownership and the parcels of land are less than a square mile.

4. The wide spacing is even more difficult to organize when some of the parcels of land (less than a square mile) are Crown reserves that have not been sold.

5. If Crown reserves on prospective dry gas acreage are to be sold will they be put up on a "gas only" basis or on a "gas and oil" basis? If the latter is the case, will the oil rights enhance the value and make the acquisition cost disproportionate?

6. Will Crown reserves that are sold on prospective dry gas acreage carry the same drilling obligations as are now in force?

It might be possible to handle Crown acreage in both reservation and lease phase on a "gas only" basis which might be substantially different to the present "oil and gas" basis. In this connection it is admitted that amendments to existing statutes and

regulations, together with the drafting of a gas only lease, would be an extremely difficult job. None the less the fact remains that today Crown reserves add a serious complexity to the problem an operator faces in the development and delineation of dry gas reservoirs.

That completes my submission.

MR. HAMLIN: Mr. Chairman, I may say that Mr. Mackenzie is prepared to answer any questions that counsel or the Board have to ask him, dealing generally with the submission. With respect to any questions dealing with the figures that he has stated have been given by engineers on the calculation of reserves in the reservoir, we are prepared to call another witness to deal with those points.

CROSS-EXAMINATION BY MR. NOLAN:

Q There was one question I would like to put, Mr. Mackenzie. At the top of page 5 of your submission, Mr. Mackenzie, line 5, you make this statement, "At the present time this plant is capable of delivering 16 million 300 thousand cubic feet per day of residue gas to domestic markets, all of which has been committed." Mr. Mackenzie, for how long has that gas been committed, for what period of time?

A I do not recall offhand. Possibly counsel could answer you.

MR. HAMLIN: A 15-year period, subject to renewal.

Q MR. NOLAN: A 15-year period subject to renewal and at what price?

A One purchaser is paying 4 cents and two other purchasers are paying 10 cents, one of them under protest.

Q Who are they, Mr. Mackenzie?

A Northwest Utilities, Leduc Utilities and the town of Devon.

Q Who gets the 4 cent rate?

A Northwest Utilities.

Q The other two pay 10 cents?

A Yes.

Q Only one of whom is protesting?

A At the moment, yes.

Q MR. HAMLIN: Perhaps Mr. Mackenzie might just add on to his statement concerning the 4 cent price?

A Yes, counsel has drawn my attention to a point there, Mr. Nolan, that the 4 cent price to Northwest Utilities is on a 1-year basis. Thereafter, other considerations are applicable. I believe it is the higher of one of three conditions; the price of Viking-Kinsella gas, if gas in that field goes to export; 90% of the export price of gas in the Leduc-Woodbend area.

Q MR. HAMLIN: Perhaps I might assist Mr. Mackenzie. The last one which you just gave is this 90% of the going price for export in the general Leduc area. The same price consideration is given for domestic gas, which will take the price throughout subject to further negotiations of the parties.

Q MR. NOLAN: Whichever is the higher?

A Yes, sir, that is right.

Q Thank you.

CROSS-EXAMINATION BY MR. STEER:

Q Is this true that the quantity you have available there is very large? The residue gas that is being sold to these three customers is a large quantity? Am I right in that?

A I would not want to classify whether they are large or small, I do not know what the yardstick is.

Q What is the figure?

A On page 3 it is stated that at the present time this line is capable of delivering 16 million --

Q MR. HAMLIN: On page 5.

A On page 5, I am sorry.

Q MR. STEER: And the quantity which would be taken by those two 10 cent customers would be what?

A I do not recall. It would probably be of the order of 2 billion or something like that.

Q Your company is faced with the alternative of finding a market for this gas?

A Exactly.

Q Or injecting it back into the reservoir for purposes of preventing waste?

A Exactly.

Q Am I right in that?

A Correct.

Q And your contract with Northwestern Utilities is of the latter category, you are selling it to them at a cheap price in order to avoid the expense of repressuring?

A There is no question about it, it is a distress signal.

CROSS-EXAMINATION BY MR. NOLAN:

Q I might have asked Mr. Mackenzie about this 16 million figure of gas delivered to the domestic market. Is all of that gas taken for use or is some of it flared, because they cannot find a use for it?

A At the moment there is some flaring of gas and I believe the reason for that is that the Northwest Utilities is in the process of making final mechanical arrangements to put the gas into their system. They have not quite completed whatever they have to do in that respect.

Q The expectation is there will be no flared gas at all?

A I would not go so far as to say that, Mr. Nolan.

Q Any gas above this 16 million feet figure would be available for other purposes?

A No, I think the ceiling there is 21 million six.

Q What happens to the gas between the 16 million figure and the 21 million six figure?

MR. HAMLIN: The 16 million figure is the present amount of gas and the 21 million six is the eventual amount that will be produced from the plant, all of which has been committed.

Q MR. NOLAN: That is the plant working at full capacity?

A That is right.

MR. C. E. SMITH: I have an odd question, if no other person has. Mr. McKenzie, have you had an opportunity of seeing Exhibit J-13 put in yesterday by Mr. Dixon? That contains a schedule that I would like to refer to opposite page 8. Possibly in order to show you what I

have in my mind, I should give it to you?

A Yes.

We have had a chance to go over these rather hurriedly but nonetheless we went over them.

Q Just by way of illustration maybe I can refer to something on that table. You will notice in the lower left-hand corner, take 1957 to the outer right-hand column, daily gas production Mcf. 31.5?

A Yes.

Q And going to D3, the right-hand column - -

A Yes.

Q - - the same year, you have in the same column 48.6?

A Yes.

Q Using 1957 purely as an illustration?

A Yes.

Q The total of that is roughly 80 billion, is it not?

A 80 million.

Q 80 million?

A Per day.

Q 80 million per day, and your present plant capacity is somewhere in the vicinity of - you gave us that?

A Yes, 21.6 return and 24 input.

Q That is at full capacity at the present time?

A That is right.

Q Can you explain to us, in Mr. Dixon's suggested, and I think it is only a suggested,table if that were accurate and you got 80 million a day, say, in 1957 where would you be at with regard to plant or the disposal of gas

or how you would approach it? Can you help me?

A Well, that is a very difficult question, Mr. Smith. I really do not know how that incremental amount would be conserved today. We have erected a plant to conserve 24 million. Our experience with it has not been too happy. While it operates very well mechanically, the financial aspect of it is the thing we are unhappy with. It does not look, at least on the present day picture, as if that plant will stand much chance of ever paying out. Consequently I do not know how the gas that you speak of, the difference between 24 million and 80 million which might be produced some day in the future, I do not know how it will be conserved.

Q You cannot help us in any way? We do not want to flare it, do we?

A No, we do not want to flare it.

Q We do not want to flare above the capacity of your plant, that is certain?

A As suggested in the brief here additional outlets are possibly the only solution.

Q What do you mean, additional outlets?

A Well, outlets that cannot be seen today.

Q That does not help me much, does it?

A In putting that ceiling on gas after exhausting every possibility we know of, and as I told you, in finally concluding these negotiations we have, in effect, an uneconomic operation.

Q And to increase it you will probably have to rebuild the whole plant to get the 80 million out, say, in 1957 and

it becomes more uneconomic, as far as you can foresee?

A Well if today's conditions continue it becomes more uneconomic.

Q But supposing you are able to sell a lot of it to Mr. Dixon, will that not help you out?

A I think possibly one of the applicants, we may be able to negotiate a better price with them.

Q It would be a better price in order to build the required facilities?

A If we could get a better income from the gas, naturally the attractiveness of building a plant would be more likely.

Q If I get you correctly, at the present moment you cannot foresee how you are going to economically handle 80 million odd, for instance, in 1957. Is that a fair way of putting it?

A Yes.

Q On the other hand that is one of your difficulties that either you or somebody should handle, if it is available according to the table suggested by Mr. Dixon?

A That is correct.

Q Did you by any chance have an opportunity of looking at his gas/oil ratios, particularly with the D3, we will say, and notice the method of increase throughout the years up to a certain point. Will you comment as to whether you agree with that probable rate of increase? You take 1960. If you look at that. I think he has about 3½ times of the 1950?

A Mr. Smith, I would like to make a general comment on that.

If you want to go into it in more detail we have in the room here reservoir engineers who can, better than I can, give you the detailed picture. My general comment is that the quick look we had at these tables presented by the Northwest Natural Gas, we believe they have withdrawn, their theoretical withdrawal rate is too rapid.

Q Yes?

A In other words, we would not disagree with the total volume that they come out with but in making the estimates ourselves, we would make the withdrawals over a longer period of time and therefore the daily withdrawal rate would not be as high as indicated here.

Q I do not think probably that answers my question. What I was suggesting was this, that you may disagree with his gas/oil ratio increase but for instance he goes from, I think it is, 700 to 2300 between 1950 and 1960. That is roughly 3½ or something.

A Mr. Smith, commenting on that generally I believe that in the D3 we do not show a gas/oil ratio performance similar to what is shown here. But I would prefer to have one of our reservoir engineers go into that. I am not familiar with the details of it.

Q May I put this to you, Mr. Mackenzie, in planning your plant, did you take into consideration the question of gas/oil ratios?

A Oh, yes.

Q And did you plan a plant to such an increase as Mr. Dixon shows, or did you plan 21 in 1960 or did you figure you

could hold it for some number of years, or what was your thought about that?

A I come back to the other general statement I made that the forecast we made when we were studying plant design, we did not come out with gas production ratios or gas production volumes as high as have been forecast here.

Q In other words, you had a slower withdrawal, to use a layman's term?

A That is correct.

Q I do not suppose you have anything to show us what your anticipated withdrawals are, daily withdrawals, as compared with Mr. Dixon's? You have not had that tabulated?

A No, but possibly Mr. Pot could give you some quick figures from notes he has.

Q Well I won't bother you with that. Now, another question, I notice in a submission that is to be presented and has been distributed by Western, I suppose it is Dr. Hawthorn's suggestion, that by 1980 there will not be any gas-cap gas available at all, because of the fact that it has already been produced with your oil and gas production. Can you give us your comment in respect to that? You have dealt with it somewhat in your submission. I just heard it as you read it. He suggests that possibility, if I remember correctly?

A Yes. I do not know if there is anything magic about 1980. What in effect we say is that there is 600 billion in that gas cap. Now some of that will break around.

Q Yes?

A It will be held to a minimum by good operating practice. I do not know how much will break around. I do not know as our engineers would want to estimate that.

Q I do not want to be unfair. I think Dr. Hawthorn's reference only is to the possibility of that situation occurring. I will refer, if I may, to a submission not yet put in, at page 6. I will read what it ways and see what you think of it. It is headed "The Deliverability Characteristics of the Gas Supplies presently serving Canadian Western Natural Gas Company Limited and Northwestern Utilities Limited." Now would you listen to this?

A Yes.

Q "In estimating the amounts of gas to be available from Leduc we have assumed an increase in gas/oil ratio and gas production of 2 to 1 over the next ten years. Thereafter we have considered the available gas to remain constant. This is believed to be conservative since it is entirely possible for the gas/oil ratio to increase more in the order of 3 or 4 to 1." I may interject there that that latter is almost consistent with Mr. Dixon's idea as demonstrated in this table. However, listen. "It is generally considered that the gas in the gas cap at Leduc will not be available for 20 or 25 years or more." That is something along the lines you suggested. "Actually, one of the gas caps will be produced to some extent daily, as will be evidenced by increasing gas/oil ratios. As a matter of fact, the gas cap may never be opened to straight gas production. Instead, all of the

gas in the gas cap may ultimately be produced through the oil wells, and this may take place to a considerable degree over the next 30 years." That was the statement I referred to.

A I see.

Q Possibly you will disagree with the extent of Dr. Hawthorn's - -

A I think our view of that would be that we concur generally, except for that last phrase, "to a considerable extent."

Q In other words you think that kind of thing might happen but not to the extent he thinks possible. I think he uses the word "possible."

A I am in a position to go along with that.

Q Just one other reference to J-13. I think you have that before you. And the table in front of page 10, headed "Forecast of Production and Deliveries - Leduc Field." You will observe there that according to Dr. Dixon's suggestion, or plan, if I may call it that, the gas cap as such apparently starts production in 1960?

A Yes.

Q You see that middle column?

A Yes, I do.

Q And increases slightly over two or three years and then takes quite a big increase from then on. Do you anticipate gas cap production as such by 1960, Mr. Mackenzie?

A I would not quarrel too much with that estimate of 9.2. I think that is just an indication of the start of that break around, the breaking through.

Q I do not think he intends it as an indication of a break

through. That is actual production from the gas cap purposely so, if I may put it that way. In other words, digging wells and taking that much out. As far as you are concerned, and as far as you have studied it, do you figure that the gas cap would be produced in that way by 1960?

A No, I do not think any operator would purposely make withdrawals from the gas cap by say opening up the gas cap. I do not want to disagree with you, Mr. Smith, but I would be a little bit inclined to the view that these people are doing just what I mentioned a moment ago, they are estimating what the break around might be into the oil well.

Q That is your interpretation, but I think probably that is not his. Now, one other question with respect to that table. Do you notice Mr. Dixon, in his plan, suggests that the D3 is through, to use a layman's language, in 1969, roughly 20 years from now?

A Yes. Well, we would extend it over a longer period of time.

(Go to page 445.)

Q That probably is because of what you suggest would be a slower withdrawal than he suggested?

A That is right.

Q Is that the only reason?

A Well, I think we have slightly different views as expressed in this report on the driving mechanism of the D-3 reservoir.

Q That is with respect to such things as water drive?

A That is right.

Q You think probably there is more perhaps of that than Mr. Dixon indicated in his submission?

A Yes.

Q I think that is all I want to bother you with, Mr. Mackenzie.

CROSS-EXAMINATION BY MR. NOLAN:

Q As I understand it, Mr. Mackenzie, it is in the different view that you have as to the proper rate of withdrawal that makes the difference between you and Mr. Dixon?

A No, I do not think that is quite true, Mr. Nolan. That is the effect.

Q Well, tell me, what is the actual rate of withdrawal now in the D-2?

A I would like one of our engineers to answer that, Mr. Nolan. I am not up-to-date in my figures.

Q The figure that I have is 8762 barrels per day in the month of August, 1950, D-2. Perhaps you could tell me if that is right by asking your advisor.

MR. HAMLIN: Yes, that is right.

A THE WITNESS: Mr. Nolan, if you would like to discuss differences in our approach and our ideas on the way the reservoir works, I would like our reservoir man to discuss it with you.

Q MR. NOLAN: But these are the actual figures on the rate of withdrawal per day?

A I presume so, I do not know.

Q Of the D-2.

MR. C.E. SMITH: What was the figure again, Mr. Nolan?

MR. NOLAN: 8762 barrels per day.

Q Well, of course, if you cut that down to half it will be extended over a period of a much longer period, twice as long?

A Quite correct.

Q And that is what you are doing, is it not?

A In the D-2, yes. Well, I think that in the D-2 probably our estimates are not too far apart from what has been estimated here. The principal difference is in the D-3.

Q Well, I think if there is anything more to be said about that we will say it ourselves and not bother Mr. Mackenzie about it any more.

DR. GOVIER: I wonder, Mr. Nolan, if there was a little misunderstanding between you and Mr. Mackenzie on that question. I believe maybe one of you was thinking of gas-oil ratios and the other one thinking of gas production.

MR. NOLAN: No. Barrels of oil per day produced, the rate of withdrawal.

CROSS-EXAMINATION BY MR. STEER:

Q I have one further question that I might ask, sir. You were talking to my friend, Mr. Smith, about these 80 millions in 1957 of gas, which was more than double the capacity, treble the capacity of your plant, and it is not anticipated, as I understand it, that you are going to expand that plant in order to be able to treat this surplus?

A Not in the light of today's circumstances.

Q So that there will be a surplus, we will say. If these figures are correct, there would be a surplus in 1957 of some fifty odd million cubic feet a day. Now, isn't it true that that gas is committed by your contract to Northwestern Utilities?

A No, I do not think so.

Q It is not committed. The only thing that is committed is what comes from your plant?

A I believe so.

Q Yes. Well then, suppose Northwestern, in order to meet the demands of its system wanted to take and treat that gas and use it in its system, that would be the most economical way to use this surplus, would you say?

A If Northwestern want to gather it and treat it and use it in their system I would think that that would be a very fine step in conservation.

Q Yes.

CROSS-EXAMINATION BY MR. FENERTY:

Q I would like to ask a couple of questions. Mr. Mackenzie, there was some discussion with the members of the Board and the witness about compression costs. I was wondering whether you happened to retain in your memory some figures. The figure I have in relation to Turner Valley is an item of about 6¢ allocated for gathering compression costs, of which 40% is being charged against absorption plant operations and the remaining 60% in effect against the consumers, and that leaves a net of 3.5¢ charged against consumers of which about 1/3 of a cent is compression costs. Have you any recollection of those figures?

A Gosh, Mr. Fenerty, I left Turner Valley in 1940. I am afraid my memory does not go back that far.

Q It just occurred to me you might have those figures. Now then, two more questions. I notice the lowest abandonment pressure you have given anywhere is 100 pounds gauge. Is that about the lowest that your experience indicates may be expected to be economically feasible in Alberta in any area?

A That is our judgment, Mr. Fenerty.

Q Yes. And one more question. On page 8 you give three ways for conservation of gas and one, I see, you stress storage purposes only, injection underground reservoir, storage purposes only. Is this a matter of recycling and final abandonment as far as areas in Turner Valley or any other areas in Alberta is concerned?

A Well, Mr. Fenerty, I view recycling as item 2, the maintenance of pressure.

Q It is what?

A It is maintenance of pressure. In other words, I would classify it in 2.

Q Oh, you think it is included?

A Yes.

Q Thank you.

Q DR. GOVIER: Mr. Mackenzie, could the basic data on which the reserves estimates are indicated on pages 2 and 3 be made available to us through another witness?

A Certainly.

MR. HAMLIN: We have mimeographed sheets setting out the basic data for the company's estimate of Leduc-Woodbend Devonian, D-2 zone and so on here, which we will be glad to file.

THE CHAIRMAN: That can go in through Mr. Pot?

MR. HAMLIN: It was my intention to put them in through Mr. Pot.

Q DR. GOVIER: Another question, Mr. Mackenzie. I wondered if you would care to give us an estimate of the extent to which the Devon plant could be operated on the capacity - - assuming that the gathering system and compressor installations were added, to what extent could the plant itself be operated beyond ratable capacity?

A That is a pretty difficult question to answer, Dr. Govier. Usually these process design people are conservative in their outlook and most operators of process equipment

finally get their plant up to more than originally designed capacity, so I think there is a bare chance that some day we will be able to put more than 24 million through some of these vessels that are now erected and designed for that throughput, but I would hesitate to say whether we would go 10% or 20% more.

Q Would it be fair to say, Mr. Mackenzie, that you would be extremely disappointed if you could not put considerably more through than 24 million?

A Well, being unhampered by a detailed knowledge of gasoline plant operations and looking at it from strictly a management point of view, I would be most disappointed if we could not get more than 10% or 20%, but I would be most surprised if we got upwards of around 75% or 100%.

Q On page 6, Mr. Mackenzie, you indicate that you arbitrarily assume about 40% is consumed in lease fuel, plant fuel, etc. I was wondering whether you used that in an illustrative sense or a considered estimate on your part?

A No, it is purely illustrative. I think in the subsequent paragraphs I try to give some indication of the complexity, the fact that some of the gas cap gas will break through, some of the solution gas will remain in solution almost until the whole reservoir is depleted, and the detailed calculations become rather involved, so what I attempted to do in that 40% of 310 billion was to make it as simple as possible and it is a judgment figure.

Q Will Mr. Pot be able to give us any further detail on that shrinkage factor, do you think?

A Well, no, I do not know that we have any information to

give you in that respect, Dr. Govier. Of course, the shrinkage factor in the plant, I believe it is 91%. Now, to the extent that you consume fuel in lease boiler plant, treaters and so on, the extent that you flare uneconomic gas which you can not gather, we have not made any calculations, there is just a judgment figure of 40%.

Q It occurred to me that inasmuch as Imperial Oil are operating this plant they should know better than anyone else what the overall ratio between residue gas available for disposition and raw gas put into the lines would be. If your company can give us any considered opinion on it we would very much appreciate it.

A Maybe this might be of some help, Dr. Govier. We could possibly give you an estimate based on production in the last half of 1951. Now, that would represent the completion of all the gas gathering construction work we are doing now and would probably contemplate Northwestern Utilities taking the majority for all of the stream that we gave them or are able to give them.

Q Well, I think such a figure would be very useful, Mr. Mackenzie, if you could give it.

A The input and the output could then be tied down but what that might be in the future, I think you get back to these judgment figures if you tried to forecast that any further down the line.

Q Yes, I see what you mean.

A We will be glad to supply that figure.

Q Thanks very much.

MR. GOODALL: Mr. Mackenzie, in your submission you mentioned the possibility that there might be some pressure maintenance carried on in the Golden Spike pool.

A Yes.

Q Was it your thought that only solution gas produced in the pool would be reinjected or had you in mind the possibility of using some excess gas from the Leduc-Woodbend pool for pressure maintenance at Golden Spike?

A We are studying that at the moment, Mr. Goodall. There is, of course, the possibility of make-up gas, injecting more than the solution gas produced. At the present time our problem in this reservoir engineering project is analyzing what effect, if any, bottom water will have on the reservoir. Now, our most recent calculations indicate that there might be, well, let us call it a weak water drive, there might be some influx, and if that is the case we probably won't have to go to gas injection for about three years, whereas looking at the problem as we did about three months ago we estimated that probably we should come to it in about a year or a year and a half's time, so our thoughts on it are that loose. Probably the three year estimate is the better one, Mr. Goodall. Now, we have just not taken the problem any further than that. We thought, well, by that time delineation drilling in the Stony Plain-Acheson area will be further along, there are various sources for make-up gas, and we will be better able to judge that at that time than we are now.

Q Would you consider it feasible to inject gas into the pool if you did have an active water drive?

A It would be feasible, Mr. Goodall, but I doubt if it would be economical. In other words, an active water drive, a satisfactory displacement by bottom water, would recover the maximum amount of oil and the injection of gas into the pool would be storage, for storage purposes only.

Q You do not think it would give you as good a recovery as the water drive by maintaining pressure with gas? In other words, driving your oil down instead of bringing it up with water drive?

A If there was an efficient water drive the pressure could be maintained by natural forces, and therefore at no cost, and maintained as efficiently.

MR. S.B. SMITH: I have no questions, sir.

THE CHAIRMAN: Thanks, Mr. Mackenzie. I presume Mr. Pot can be available next week, can he, Mr. Hamlim?

MR. HAMLIN: Yes.

THE CHAIRMAN: Would any day next week be all right?

MR. HAMLIN: Yes, any day next week.

THE CHAIRMAN: I believe that Mr. Davis would like to make some statement to the Board in connection with this matter of cuttings and cores which both Mr. Dixon and Mr. Dodge took issue with. Would it be satisfactory to counsel here if we had Mr. Davis submit a brief to us and distribute it to the various people in order to try and save time?

MR. NOLAN: We would much prefer that that be done, as far as we are concerned.

THE CHAIRMAN: Would you check that, Mr. Steer?

MR. STEER: Mr. Davis prefers and will be prepared to make that statement now. It will be very brief.

MR. DAVIS: Very brief, and then I will submit the written brief.

THE CHAIRMAN: Suppose we give you 10 minutes, Mr. Davis?

RALPH E. DAVIS, already sworn, testified as follows:

May I speak now. I wish to discuss the matter of the study of drill cuttings recovered from wells and the reference I made to having done that in the Jumping Pound field. At the outset I will say that a paper was published in 1945 by A.D. Bolness and R.A. Fitting. This appears at page 179 and the pages following in the transactions of the American Institute of Mining and Metalurgical Engineers, their volume 160. In the paper there is described a study of core data from dolomites. This year there was presented at the meeting of the Petroleum Branch of the American Institute of Mining and Metalurgical Engineers a paper entitled "Sample Grading Method of Estimating Gas Reserves Developed for the Permian Dolomite of the South Hugoton Field" by D.L. Katz, that is, Dr. Katz of the University of Michigan; C.E. Turner, head of the reservoir economics development of the Phillips Petroleum Company; R.D. Grimm, his first assistant, John

A. Vary, Michigan Consolidated Gas Company in charge of gas production, and J.R. Elenbass, his very able assistant. Of this paper I have a few copies just received this morning. They discuss the study of well cuttings based upon an examination of the cuttings from more than 700 wells, 762 wells. This work was carried out some time during the past year. In addition to the 762 wells, which were wells that had not been cored, there were available core plugs and cores from a total of 23 wells and core plugs, 2547 core plugs, had been prepared and tested for porosity and permeability, and of these 2077 were still available at the time of the study this past year. This study was undertaken for these reasons. In 1945 the Michigan-Wisconsin Pipe Line Company was endeavouring to secure a certificate of convenience and necessity to build a pipe line from the South Hugoton field to Milwaukee and and also to Detroit and I was engaged in the study of the gas supply to be available to that company, had a contract with Phillips Petroleum. Phillips Petroleums control the reserves on some 600,000 acres. At that time there were either 16 or 18 wells that had been cored and there were a total of about 25 or 26 other wells in an area of some 600,000 acres. To get an idea of the porosity I relied upon the cores and the laboratory tests. To get an idea of the thickness of the pay throughout the field I also studied those drill cuttings from the 25 or 26 other wells and made no attempt at that time to judge porosity. We did not have very great success before the Federal Power Commission. The Panhandle Eastern Pipe Line Company entered

the case and fought us to a standstill, employed able geologists as well as lawyers. We got a certificate but not for the quantity of gas that had been requested. This thing went on through a total of four or five years and the last Hearing was in the early months of this year. Some time more than a year ago I went to Captain Pinck, who is president of Michigan-Wisconsin Company, and also to Mr. K.S. Adams, President of Phillips Petroleum Company, and I told them both I knew of no way of proving our case as to our total known supply, deliverability, etc., unless we could make a very thorough and careful study of the cuttings from all wells. That program was decided upon. Mr. Adams asked me to associate myself in planning the work, and the study was carried on during a period of at least six months. At one time there were over 50 people engaged in that work. Six selected geologists spent several months' time studying the cuttings from those 762 wells, using a 12-power microscope, grading the samples from 0. 0 could see no porosity, 1 slight porosity, 2 a little more porosity, and 3, 4, 5 and 6 was very good porosity. This paper that I have a few copies of shows photographs of Hugoton Dolomite when magnified 12 times and grades 0, 1, 2, 3, 4, 5 and 6, and this paper is a complete discussion of the methods used in that undertaking. There is this statement as to conclusions, and it is very short:

" The procedure presented herein for estimating the net reservoir void space by sample grading can be reliably applied to all dolomitized limestone

"formations in which the geometry of its internal-void space is primarily determined by intercrystalline type porosity. In reservoirs for which this procedure is valid the variations of porosity and permeability can be evaluated from well samples with an accuracy approaching that for cored wells. For such reservoirs, the use of this procedure reduces the number of cored wells from that ordinarily considered adequate for the preparation of dependable reserve estimates."

Q MR. STEER: You will file a complete statement, Mr. Davis, and you have already consumed our 10 minutes.

A You do not need to tell me that, sir.

Q Was that the method that you used in estimating the porosity and thickness of the Jumping Pound sand?

A Only to this extent, I had no yardstick to determine from the Jumping Pound field. The yardstick I had was the yardstick determined in the South Hugoton field but for a dolomitic limestone, and I made no effort in Jumping Pound to arrive at an accurate estimate of porosity but only I graded the porosity out there and found none of it to be what in South Hugoton would have been called grades 4, 5 and 6. I classed it all as being in grades 0, 1, 2, 3, that is, the lower type of porosity. May I submit this? Thank you very much. What about Mr. Dixon?

PAPER PUT IN AND
MARKED EXHIBIT J-16.

ALBERT D. BROKAW, recalled,

already sworn, examined by Mr. Nolan, testified as follows:-

Q Now, Dr. Brokaw, have you before you Exhibit J-12?

A Yes, sir.

Q And you are still under oath, aof course?

A I am.

Q Have you a correction to make in Exhibit J-12?

A I have. On Page 9, in the second paragraph, the figures are incorrectly entered.

Q Now, what line are you speaking of?

A In the sixth line, the figure of 1,000 p.s.i.a.

Q That is the sixth line of the second paragraph on page 9?

A Yes.

Q Yes?

A 1,000 p.s.i.a. should be corrected to read 1,414 p.s.i.a.

Q Yes?

A And the second line below that, in the very lefthand end of the line, the figure of 140 p.s.i. should be changed to 190 p.s.i.

Q Yes?

A And in the line near the bottom, really the third from the bottom....

Q Yes.

A Oh, yes, I have it. The third line from the bottom, again the 1,000 p.s.i.a. should be corrected to read 1,414 p.s.i.a. And following on in that sentence the figure of 4500 MCF per day should read 3550 MCF per day.

Q Yes?

A There is also an omission on page 29.

Q Yes?

A In the column on the right in which it says "Open flow MCF", that should be, or should have read "Average Open Flow MCF".

Q All right, thank you, Dr. Brokaw.

.....

CROSS-EXAMINATION BY MR. McDONALD:

Q Dr.Brokaw, if you will refer to page 9 again, where you were dealing with the method of calculating the deliverability by use of the differential.....

A The constant differential.

Q The constant differential. Would you enlarge on that a bit for me?

A That is not my method necessarily. It is a matter which has been, at least, which I have been considering for some time, and wondering if there were not some such method which could be applied which would take care of the differences in the full characteristics of certain wells and fields rather than a definite limitation to the open flow capacity of 25% of the open flow capacity of the well. The point is that some wells can produce much more than 25%, or substantially more than 25% of the open flow capacity without damage, because the differential pressure at the bottom of the well, that is, the difference between formation pressure and sand face pressure is such, I mean, the characteristics of the well are such that it does not take the same difference between the formation pressure and the sand face pressure to produce a given amount of gas, and it is pointed out a little farther on, with regard to that, and it is explanatory of that a

little farther on.

Of course, the limitation to 25% as in most cases where it has been applied, I think has not been based on a detailed analysis, but it has been an easy and convenient thing. It is a little like the speed limits on some of our roads, they put a 25-mile speed limit in towns, and that goes, and in other places they do not.

I do not know of any analytical basis upon which such a figure has been based. Originally in the earliest restrictions, or in the earliest activities in control of gas wells in Texas, that I am familiar with, if I remember correctly there was an arbitrary limit of 50% of the open flow capacity imposed. As time went on there developed all sorts of controversies because you might have a well which was connected to the line, and your next door neighbour have one that was not connected to the line, and by drawing 50% of the open flow from your well, and your neighbour not taking any or not having any production, you were accused of stealing his gas.

There is a very tortuous legal background involving the law of capture which came into that, and then it became necessary to place restrictions, not solely from the standpoint of conservation, but in the matter of equity, and this led in some States to a requirement of a rateable take.

Now, that sounds very simple, but I suppose that there have been more controversies before administrative bodies, and carried from the

decisions of administrative bodies to the Courts over this matter of equitable take or rateable take that almost any other feature of the control of production. It applies equally to oil, and, of course, the thing has developed into some terribly intricate bases, but, so far as I know, the actual analytical determination from the standpoint of conservation - only an actual analytical determination of the proper drilling of wells has never been made very often, although there have been a great many studies, and they are being carried on.

Q Well, I do not want you to go into it too far?

A Excuse me.

Q The point I had in mind was this, the 25% has an historical background which you have touched on briefly?

A That is correct.

Q But it hasn't had a great deal of engineering background so far as you know?

A There is nothing sacrosanct about it.

Q Thank you.

MR. STEER: May I ask Dr. Brokaw a question or two?

THE CHAIRMAN: Yes.

.....

CROSS-EXAMINATION BY MR. STEER

Q Your estimates of reserves, as I gather, Dr. Brokaw, are founded almost entirely on Hume?

A That is correct.

Q And Hume, as I gather it, has founded his on information that he gets from the various companies?

A I think he also uses the files of the Board extensively.

Q Quite so?

A Anyone making a broad examination has to use all of those sources.

Q Yes. And you have made no personal check as to the accuracy of any of those figures, whether found one place or the other?

A You mean the source figures?

Q Yes?

A No. I have checked some of them, but not absolutely every one. I have checked them only with regard to the Board files and things of that kind.

Q Let us look at Viking-Kinsella, for example?

A Yes, sir.

Q Have you checked the area?

A I know the area that Dr. Hume uses is different from the area that you use.

Q Have you a definite opinion or definite information that the area, the productive area in the Viking-Kinsella field is 572 square miles?

A I have not studied that since 1917.

Q I see. So that you cannot have any such opinion?

A Of course.

Q No. And have you a definite opinion of your own as to the thickness of the sand?

A Only from the records which I have seen. I haven't examined all of them.

Q And that would also apply to porosity and connate water?

A That is true. I have seen one or two very elaborate analyses of that situation. One was prepared by the

Imperial Oil Company and one prepared by the engineer, I think his name was Pitfield, of the Northwest Utilities.

Q Quite so.

A But I haven't had access to those in connection with this investigation.

Q I see. And what those investigations showed you do not recall now?

A Well, I recall they showed very close agreement as to total reserves of Dr. Hume.

Q Yes?

A They were all of the same order of magnitude.

Q When made?

A I think I saw Pitfield's in '47, and the Imperial's, I think, in '48. I am not sure about that, Mr. Steer.

Q Yes? And so far as Princess is concerned, you have heard

A Mr. Davis's evidence on that here?

A I did.

Q That in his opinion the recoverable gas, the percentage of recoverable gas out of Princess, the presently recoverable gas was some 40 billion cubic feet?

A Yes.

Q And that he regarded the area that had to be explored there as some 2000 square miles?

A He testified to that effect, yes.

Q And have you any idea of the number of wells that have been drilled in that area to explore it?

A I cannot answer that quantitatively, except that I spent about two months or about six weeks in studying the records of the area in 1947, and another week or two in 1948.

Q Yes?

A Now, I do not carry those figures in my memory, but I think I probably spent more time on that particular field than Mr. Davis has.

Q Although he was sent up here by the United States company for the express purpose of ascertaining whether or not there was enough gas there to justify a carbon black plant?

A I do not know anything about his connections at all, no.

Q You do not know?

A No.

Q His study, I am instructed, was made for that purpose, and he gave us his conclusions the other day. Would you regard 60 wells as a sufficient test of an area of that size?

A No, not necessarily.

Q Now, I am told that there are in that large area at the present time some three producing gas wells, one of which is allotted to the Town of Brooks, and that the others are either insignificant or closed in, would you agree with that?

A No, I think there are more than that.

Q Yes?

A I cannot tell you exactly, but I am quite sure. There are three wells of California Standard that are closed in. I am not quite sure about that, because my last check-up has been this last spring.

Q And if the evidence is that the area is a collection of gas pockets, what would you say?

A I wouldn't quite say gas pockets. The distributiom of the Basal Lower Cretaceous sand is somewhat erratic.

I think it can be worked out. I do not think it has been quite adequately done, probably, but I rely to a considerable extent on the information of Dr. Weir of the California Standard, who has given the matter much closer study than any other person excepting thepeople in his organization, and I am sure that Dr. Hume's data were derived largely from Dr. Weir.

(Go to page 466).

Q I am told that the Brooks well, that is the well that is assigned to the town of Brooks, is a good gas well?

A I think that is correct.

Q I am also told that 4 or 5 other wells were drilled in the immediately surrounding vicinity without result?

A That is correct.

Q And would you say that the formation is lenticular in that whole area?

A I do not think that is quite a proper designation for it but it may fit fairly well. I am quite sure that the Brooks well is not in the same pool as the Princess area. I am sure of that. It is another pool. How extensive that is I do not know. It is apparently not very great whereas there are evidences that some of the others are considerably greater.

Q Would you not say as your opinion that throughout this large area you would find similar small pools of gas such as which exist around this Brooks well?

A You might find others, yes.

Q Would you say as your opinion that is characteristic of this large Princess area?

A No, I would not.

Q Are you prepared to say that in your opinion, there is some such large volume, some such large reservoir of gas as is found in Jumping Pound?

A No, not in the same order.

Q Or Viking-Kinsella?

A No.

Q There may be some of the magnitude of what I will call a

pocket. Will you let me talk about Brooks as a pocket?

A Well, certainly, you can talk about anything you wish.

Q What do you say about it, is it a pocket?

A I never use the term "pocket".

Q What term do you use?

A A small local field or - -

Q Would you expect to find in the Princess area a field of one-half the magnitude of the Jumping Pound field?

A Not in a small area but in a large area it is entirely possible.

Q It has, according to Mr. Davis, an area of 2000 square miles. Would you expect in that area to find such a field?

A Probably not one but possibly several, but not as big as Jumping Pound. Geologically and in every way they are not in any sense comparable.

Q I just have one other question. I think it has to do with your J-12?

A Yes, sir.

Q Will you look at the table with respect to the Jumping Pound field?

A Yes, sir.

Q Following page 15.

A Following page 15?

Q Following page 15, you start there with gas in place 942 billion?

A That is correct.

Q And over a period of years up to 1981 you take out 428 million?

A Well that is less than the amount taken out. That is the

net rather than the gross. The 428 million is my estimate of the possible delivery, a forecast of delivery.

Q And how much gas is left in the reservoir at the end of 1981?

A According to the reserves which we use here there are almost 437 billions in place of that 942 and the difference is 504 billions, plus a little.

Q And the field has been taken down to what pressure?

A 1842 pounds.

Q Are you proposing - you are not proposing then to abandon that?

A No. Not at all.

Q I think Mr. Davis gave an estimate of 401 billion.

A I think it was an even 400 and that was deliverable, producible, available gas and comparable to my figure of 428.

Q He took his figure down to 200 pounds abandonment pressure?

A Yes.

Q Would you say that is a reasonable abandonment pressure?

A I would not be sure at all with that. I think that is probably too low again. Now abandonment pressure is something we never can determine in advance. You know we think we shall have to abandon wells when they get down to 400 pounds but we find that we can go on producing and go on producing them until we get into trouble.

Q You might put your abandonment pressure up higher than Mr. Davis?

A Yes.

Q The difference between you and him is when you think this field should be abandoned. You have a field with 457 billion feet of gas in place?

A Yes.

Q Of which a percentage would be marketable?

A Well I have not figured that.

Q A large proportion of it would be marketable?

A Yes. Again you see, Mr. Steer, that would depend on the cut-off point. If you reduced it from 1800 to 500 pounds it is different from what it is if you reduce it to 200 pounds.

Q That is all, thank you.

EXAMINATION BY DR. GOVIER:

Q Dr. Brokaw, I wanted to ask you a question along the line of that asked by Mr. McDonald earlier. You indicate on page 9 of your Exhibit J-12 that a possible concept of a constant differential should have some weight in setting allowables for gas wells. Before I actually ask my question, Dr. Brokaw, I would like to tell you that the Board at one time took under its regulations a regulation governing gas well spacing and 25% of the open flow. A short time ago when we were revising these regulations we deliberately left both of those out because we knew that in a pinch we could always put them in very quickly. We were giving the whole question study in trying to decide whether there should be some revision of these concepts or either one of them. We gave a lot of thought to what was being done in Kansas, Texas and Oklahoma. We still have

not made up our minds what is the right thing to do, and for that reason we are very interested in these notions of yours and I wonder if you could tell us just a little bit more and particularly whether you could in any practical way, from the administrative point of view, introduce this concept or even of giving some effect to part of this concept.

A It is a rather difficult question and if I were to answer categorically that we should have tests made of the flowing and closed pressures made at intervals I might get in wrong because the people of Alberta would not permit me to come back. But it seems to me that from a mechanical point of view the concept of control by differential pressure is a sounder way than by an arbitrary ratio or a percentage of the open flow capacity. I think that it might be possible - I have never undertaken this, but I think it might be possible to bring it up from the sand face and consider the possible differentail pressure at the surface of the well, your tubing pressure against the casing pressure, and considering these against the delivery actually measured might yield material of considerably more value. I have the feeling that the greatest or the most desirable feature on some such thing as this is that if we limit on the basis of open flow capacity of a field in which the wells are declining, or a well such as I have expressed here, that it is perfectly possible for the field to become uneconomic from the standpoint of its deliverability to the line. There may be another way of escaping

that dilemma and I think it is ordinarily handled, in some areas at least, on the basis of a minimum well, say a marginal well, that is allowed to produce what it can into lines without reference to its potential, simply with the thought that it cannot possibly do very much damage because there is not very much left to damage there. I can see a very considerable reason for applying such a principle. Now one of the difficulties in understanding the situation with reference to the limit of production is that it involves two elements, as I have pointed out to Mr. McDonald. There is of course the element of conservation and that is a thing in which the Board and we all are deeply concerned. There is also the economic feature of making money out of the gas business and in making a study, in fact in most of the gas-producing States, property ownership, including mineral right ownership, is divided. In such fields as the Hugoten, for instance, it is very elaborate - I mean the Kansas end of the Hugoten field, it has a rather elaborate schedule on which well deliveries are controlled. A situation arose that they had developed on the basis of one well to a section and some of the wells belonged to people who had contracted to sell some of that production. But I happen to know one man who had a section alone and a nice well in the middle of it and he sat there for years and nobody would buy his gas. And that developed into a situation which finally led to installing in that field at least a rateable take which was not a matter of conservation but a matter of distribution

to the individual producers who were available in the field. On the whole subject it seems to me that in the first place each field must be considered by itself and we should learn as much as we possibly can about the characteristics of the field and we might classify them into three or four types of reservoirs.

(Go to page 473.)

A. D. Brokaw,
Exam. by Dr. Govier.

A For instance, the type in Jumping Pound and Pincher Creek would include Turner Valley if it had not been for the oil in Turner Valley, but take Jumping Pound and Pincher Creek as a type of deep-seated high pressure reservoirs, drilling costs of $350,000.00 at Jumping Pound for the wells without the fittings and trimmings. It costs about 800 odd thousand in Pincher Creek, that is the Globe well. I believe their estimate is $880,000.00. So far as I have been able to learn in conversation with a man who actually sat on the well during the tests, there was no water in Pincher Creek No. 1, and I think the same is true of Walter Marr No. 1. They are high on the structure as we know the structure or as we think it is, and we know that the reservoir rock is a competent rock, so that from the standpoint of damage to the well I should think probably the sensible thing would be, if it were possible, to base the allowable production from wells in a field of that sort, until we find out our original judgment was wrong, to allow them to produce what there is an economic outlet for, trusting to the management that with its investment of $800,000.00 a well in the project, plus a great deal of other investment, also with its skill in operation, and in that particular case with having in its possession a very excellent research and laboratory outfit, I think probably the judgment of the operator himself might be the guiding principle, especially if there is no division of ownership or if the ownership, both royalty and reserves, or leasehold, are unitized, and very much the same sort of thing on a lesser scale could apply to Pincher Creek.

In Mr. Hawthorn's study of Pincher Creek he charged about 27 wells, which was necessary to maintain delivery on this 25% capacity, under the assumptions which he made, and I think his assumptions were entirely valid. But I think it is entirely probable that those wells, many of them, could produce more than that.

Then we get into a very great complication which has to do, of course, with the precipitation of condensate within the formation under what has been even called retro-grade condensation. There again the reservoir engineers and not myself would be the people to judge. There are only two or three of those fields, only two now, in such shape that we might anticipate production from them in the very near future.

The next type of field would be the fields in more or less gentle structural situations, the sand fields and the limestone or dolomite fields, in which the performance is much as it is in sand fields. And those, I think, could well be divided into two classes, fields in which we have water at the base of the gas and fields, such as Viking-Kinsella field, in which water does not seem to be localized down-dip from the fields. The control of wells in a field such as the Pendant d'Oreille field, for instance, where, if I am not very much mistaken, we have a water-gas interface on the easterly side of the field, certainly wells in that area should be very carefully watched, and in a case like that I think it is probably wise at the start at least to put on some arbitrary figure but not to make it binding on all wells

and to have the thing adjusted. Now, a well on the low side or on the east side of the Pendant d'Oreille field might well draw in water or permit water to come in under the differential pressure and seal off areas or volumes or gas reservoir from which production might otherwise be obtained. Higher up on the structure, if the wells were drilled high up on the structure but still in the thick part of the pay zone, I think a row of wells along there could be allowed to produce very much more than 25% of their open flow capacity, although I do not know what the flow characteristics of those wells are.

Another point which I think might be mentioned is the matter of experience in the operation of the field. I believe that in a logical application of the controls we have to be a little more careful in new fields than we do in fields that have already established their mode of behaviour. The Viking-Kinsella area, for instance, has been operated for years. The company has established a competent personnel of reservoir engineers and gas engineers. I highly approve of the sort of tests which were made to see how a well stands up on 10 days' production. That sort of thing is old fashioned but it is good. The only thing I should like to see there is to see that some sort of thing against a variety of delivery pressures instead of the most normal pressure of the sand, I mean, the normal pressure of the lime. But it does seem to me that unless there is some difficulty developing you can rely on the experience of the operators of a pool which has been in operation for a long period of

time, and you can be assured also that they are jealous of the investment they have, and I think that the application of good conservation practice is also good economic practice, and perhaps I could reverse that. Perhaps I am being too prolapse, Dr. Govier.

Q Dr. Brokaw, do you know of any place where this idea of a fixed differential is used at all for control of production rates?

A No, that was an idea of my own, and I wondered how it could be applied. I want to study the subject.

Q Your only thought at the present time is maybe there is some way of bringing that up to the top of the well?

A That is the only one I have so far.

Q Do you feel fairly competent, Dr. Brokaw, that the differential between the reservoir pressure and the sand face pressure is the only thing which can cause damage to a gas well?

A Oh, no, I do not think that is so. You can have caving which probably has no bearing on that.

Q Well, let me change my question. Do you think it is the only thing related to producing rates that could cause damage to a gas well or loss of reserve or waste in general?

A I only think at the moment of failure of casing or something of that sort, which is one of the dangers in our deep hydrogen-sulphide fields because we are all familiar with the enbrittlement of tubing which took place at Pincher Creek. There is another feature in the several characteristic curves also which probably needs further exploration. I was a little surprised to see that Pincher

Creek No. 1 on perforation gave a slope of about .685, and I talked at some length with a man who was on the well at the time the tests were made, and the perforations in that well, I think, are entirely inadequate, I mean, for their later tests. They have not yet acidized it but purely as a matter of physics I have been turning over in my mind the question of whether an inadequately perforated well might not show entirely different flow characteristics from what we would expect from the difference between the formation pressure and the sand face pressure and simply because the pressure on the inside of the pipe is not the true sand face pressure. Do you see what I am driving at?

Q Yes.

A But I do not think of anything else except the failure of casing. The breaking in of water is probably a matter of permeability and differential pressure. Now, I might withdraw just an inch on this constant differential pressure because if we have a constant differential pressure through a long period of time of course it does have some accumulative effect which might be somewhat dangerous but it seems to me in wells of moderate size the matter might well be explored. I have no facilities for actually undertaking the investigation excepting in the matter of thinking it through, but I should like it very much to do that.

Q Well, thanks very much, Dr. Brokaw.

THE CHAIRMAN: Thanks, Dr. Brokaw.

Discussion.

MR. STEER: Mr. Chairman, Mr. Davis asks me to say I was quite wrong in assuming a 200 pound abandonment pressure in Jumping Pound, it should have been five or six hundred.

THE CHAIRMAN: Mr. Nolan, before Dr. Brokaw goes, do you intend to lead any evidence as to whether or not the producers in the field are prepared to drill the number of wells specified in the delivery schedules?

MR. NOLAN: No, sir. I understood that the producers themselves would come forward, at which time they could give the Board some indication of their drilling program. It is very difficult for us to provide such information.

THE CHAIRMAN: I was wondering if you could get some information. The evidence given by the gas company is that they are not prepared to drill the number of wells.

MR. NOLAN: I am afraid we won't be of assistance to the Board in that regard.

THE CHAIRMAN: Well, we will adjourn until Monday, unless you have anything else, Mr. Nolan.

MR. NOLAN: No. I have one or two things I am going to put in Monday morning but they are documentary, then Mr. Dixon will be available.

(The Hearing then adjourned until 9:30 A.M., Monday, November 6th, 1950.)